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HD 172256 REVISITED+

Variations of the Be star HD 172256 (SAO 187112) have already been reported by Heck and Manfroid (1982) from 30 uvby observations obtained over seven consecutive nights in August 1981. The observed (peak-to-peak) amplitudes were $0^m.103$, $0^m.023$, $0^m.026$ and $0^m.069$ for V, b-y, m_1 and c_1 respectively, while the absolute internal accuracy for stars of a similar type was $0^m.011$, $0^m.005$, $0^m.007$ and $0^m.009$ respectively. The variations were therefore highly significant. In particular, significant variations of up to $0^m.1$ occurred within a single night. On that basis, HD 172256 was added to the growing list of Be stars showing variations on a time scale less than a day or two (Percy, 1982).

Table I

Variations of HD 172256 during June 1983 (observations at ESO 50 Danish telescope)

JD_o 2,445,000 +	V	b-y	m_1	c_1
500.6002	8.694	0.099	0.025	0.108
500.8347	8.759	0.115	0.003	0.129
501.8070	8.751	0.116	-0.008	0.141
502.5775	8.697	0.114	0.004	0.113
504.6313	8.713	0.112	0.005	0.121
504.7729	8.713	0.131	-0.023	0.123
505.5828	8.714	0.089	0.050	0.083
505.7601	8.698	0.119	-0.016	0.141
506.7184	8.731	0.119	-0.010	0.130
506.8243	8.731	0.115	-0.006	0.135
508.5654	8.686	0.125	-0.001	0.092
508.6523	8.725	0.128	-0.015	0.128
508.7458	8.731	0.120	-0.016	0.137
508.8312	8.704	0.110	0.005	0.122
508.8734	8.708	0.113	-0.013	0.133
509.6011	8.724	0.110	-0.011	0.145
509.7108	8.708	0.121	-0.007	0.120
509.8014	8.719	0.120	-0.013	0.130
509.8661	8.710	0.108	0.006	0.120
509.9035	8.706	0.111	-0.009	0.150

+Based on observations collected at the European Southern Observatory, La Silla, Chile

Table II

Variations of HD 172256 during July 1983 (observations at ESO 1m telescope)

JD_o	V	b−y	m_1	c_1
2,445,000 +				
518.5521	8.683	0.127	−0.015	0.142
518.6826	8.727	0.120	−0.013	0.145
518.8725	8.721	0.120	−0.014	0.131
542.6204	8.733	0.119	−0.004	0.142
542.6631	8.745	0.122	−0.008	0.141
542.7812	8.725	0.117	−0.002	0.126
545.5036	8.707	0.116	−0.004	0.108
545.5936	8.746	0.077	0.043	0.120
546.5020	8.692	0.119	−0.002	0.128
546.5913	8.723	0.121	−0.006	0.137
546.7245	8.820	0.116	−0.013	0.160
546.7508	8.802	0.116	−0.001	0.138
547.4952	8.677	0.125	−0.015	0.126
547.5527	8.708	0.125	−0.014	0.127
547.6415	8.747	0.112	0.001	0.129
547.6751	8.736	0.117	0.000	0.126
547.7302	8.743	0.112	0.012	0.101
547.7727	8.752	0.114	−0.012	0.114
548.4856	8.712	0.115	−0.002	0.139
548.6516	8.725	0.106	0.014	0.116
548.6761	8.719	0.109	0.004	0.123
548.6965	8.743	0.102	0.014	0.116

Table III

Peak-to-peak amplitudes of HD 172256 variations

	V	b−y	m_1	c_1
August 1981	0.103	0.023	0.026	0.069
June 1983	0.073	0.042	0.073	0.042
July 1983	[illegible]	[illegible]	0.058	0.059
June-July 1983	[illegible]	[illegible]	[illegible]	[illegible]

In several stars, such variations have been attributed to non-radial pulsation. Models involving rotation or duplicity have also been proposed. The observations of Heck and Manfroid (1982) were analyzed for periodicity using Deeming's (1975) method. The V observations could be fit by periods of $0\overset{d}{.}308$, $0\overset{d}{.}236$ or $0\overset{d}{.}444$ (in order of decreasing significance: these periods are related by 1 cycle/day), but the c_1 observations could not.

Additional observations have therefore been carried out in June and July 1983 at La Silla, Chile, with the 50 cm Danish and 1 m ESO telescopes, respectively. The data collected are presented in Tables I and II. The amplitudes

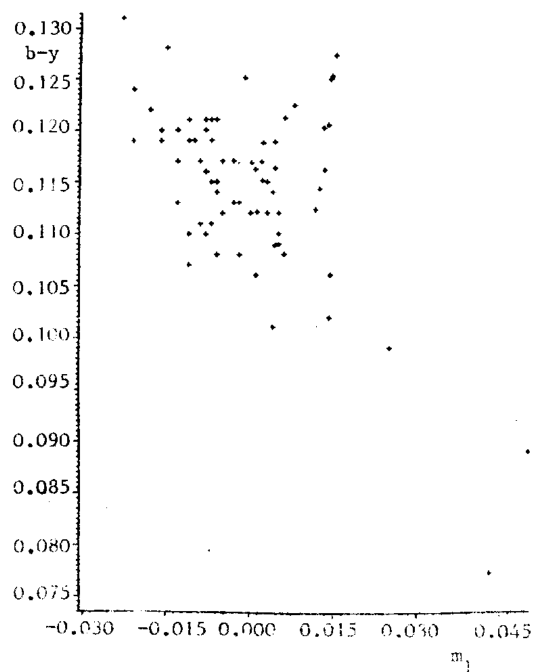

Figure 1

Correlation between b-y and m_1 for HD [illegible] for observations carried out in August 198[illegible], June 1983 and July 1983.

are given in Table III and are large compared to the absolute internal errors estimated here to be $0^m.011$, $0^m.005$, $0^m.007$ and $0^m.009$ for V, b-y, m_1 and c_1 respectively in June 1983, and $0^m.012$, $0^m.006$, $0^m.008$ and $0^m.011$ in July 1983.

Again, there are variations of several hundredths of a magnitude on many nights, including a variation of $0^m.128$ within $0^d.22$ on JD 2445546. It has not been possible, however, to extract any strict periodicity from the data, and in particular, those mentioned earlier are not present again. Moreover, the variations in the different colours are mostly uncorrelated.

Only b-y and m_1 seem clearly anticorrelated (see figure), with m_1 varying more than b-y. Since $m_1 = (v-b) - (b-y)$, this would mean that (v-b) is also anticorrelated to (b-y).

A. HECK[1], J. MANFROID[2++], J.R. PERCY[3]

[1]Observatoire Astronomique, 11 rue de l'Université. F-67000 Strasbourg, France

[2]Département d'Astrophysique de l'Université de Liège, avenue de Cointe 5, B-4200 Cointe-Ougrée, Belgium

[3]Department of Astronomy, University of Toronto, Toronto, Ontario M5S 1A1, Canada

++Research Associate, National Fund for Scientific Research

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OBSERVATIONS OF TWO SUSPECTED NOVAE IN CARINA (1953) AND VIRGO (1929)

During a stay at the Harvard College Observatory, photographic plates were examined for outburst photographs of poorly known or suspected novae, in order to determine accurate positions and to prepare finding charts for a forthcoming catalogue and atlas of galactic novae (Duerbeck 1984). Two objects, until now listed only in the Catalogue of Suspected Variables (Kholopov 1982), were confirmed.

1. NSV 04884 = Nova Car 1953

During a search for planetary nebulae, Perek (1960) discovered an emission line object on objective prism plates taken with the Tonantzintla Schmidt telescope on 1953 February 8/9 and March 10/11. It could not be found on plates taken in subsequent years.

The star is present on plates taken with the Bache telescope. It is already visible on 1953 January 23, at photographic magnitude 14.5, while the preceding plate of the field, taken on 1952 March 28, does not show the star. On a plate of 1953 March 19, it is $17^{m}.0$.

2. NSV 06201 = Nova Vir 1929

Schneller (1931) observed the star on two patrol plates of 1929 February 1 (11^{m}) and February 3 ($12^{m}.5$). The object was not seen on 1929 February 9 and on all other plates available to him.

The star is not seen on Harvard patrol plates of the AC series, taken 1929 January 20, fainter than $12^{m}.7$, and January 23, fainter than $10^{m}.4$; a plate taken 1929 January 26 could not be retrieved. It is seen on plate AC 27289 of 1929 February 4/5, at magnitude 12.4, and on plate RH 982 of 1929 February 7/8, at magnitude 13.0.

Finding charts and accurate positions of the novae will be given in the forthcoming catalogue.

Acknowledgements: I thank Dr. M. Liller for the permission to use the plate collection of the Harvard College Observatory, and for her advice. I also thank the Deutsche Forschungsgemeinschaft for a travel grant (Du 107/4-1) that made the stay at the Harvard College Observatory possible.

H.W. DUERBECK

Observatorium Hoher List
der Universitäts-Sternwarte Bonn

5568 Daun, F. R. Germany

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WALRAVEN VBLUW PHOTOMETRY OF FIVE SUSPECTED VARIABLE STARS*

While observing pulsating variable stars with periods between one and three days with the Walraven five channel photometer attached to the Dutch 91 cm telescope at the European Southern Observatory, La Silla, Chile, five stars suspected of variability were observed occasionally in order to confirm their variability. They were selected on the grounds of the spectral information given in the "New Catalogue of Suspected Variable Stars" (Kholopov et. al, 1982).

For a detailed analysis of the properties of the VBLUW system and its instrumental implementations, we refer the reader to the article by Lub and Pel (1977) and the references given therein. For the understanding of the tables in this paper it is necessary to recall the fact, that in the Walraven system all measurements are expressed in terms of log(intensity) units.

All the data presented in this paper were obtained differentially in respect to nearby comparison stars whose intensities were tied into the standard Walraven system by frequent and nightly observations of a number of primary standards. The conventional transformation and extinction formulae were applied. The integration times (most of the time in the order of a few minutes) were chosen with the aim of attaining a 1% accuracy. A more detailed description of the observing procedures and their internal errors will be given in a subsequent paper on the observations of known pulsating variables.

Table 1 contains all the data on the five local standards used as comparison stars. Nights of photometric quality were only used for the determination of these values. The columns give: (1) HD number, (2) Walraven data with standard deviations, (3) number of observations and (4) V_J magnitude as derived by the conversion formula given by Pel (1976) and NSV-number of the corresponding variable. The standard deviations listed indicate non-variability of the comparison stars at the 0.01 magnitude level.

*Based on observations collected at the European Southern Observatory, La Silla, Chile

Table I

VBLUW-data for the five local standards used

HD	V	V-B	B-U	U-W	B-L	n	V_J
8188	-0.3212	0.2176	0.3138	0.1933	0.2142	4	7.64
	± 48	12	32	45	45		(NSV 470)
160069	-0.4483	0.0055	0.2356	0.0594	0.0730	11	7.99
	± 49	15	16	57	39		(NSV 9246)
177681	-1.0117	0.1204	0.3161	0.1210	0.1184	7	9.38
	± 41	29	25	42	39		(NSV 11708)
189270	-0.6963	0.2278	0.2899	0.1825	0.2048	11	8.57
	± 67	33	35	62	47		(NSV 12665)
213543	-0.7870	0.1672	0.3428	0.1788	0.1922	6	8.81
	± 31	14	49	62	44		(NSV 14164)

Notes on individual stars:

NSV 470 = BV 637 = HD 8093 (F0): The star was discovered by Strohmeier, Knigge and Ott (1965) as variable with an amplitude of 0.3 m_{pg}. Table II lists our data on this suspected variable. As in Table I, for the convenience

Table II

VBLUW-data for NSV 470 = BV 637 = HD 8093

JD_{hel}	V	V-B	B-U	U-W	B-L	V_J	$B-V_J$
2445541.817	-0.746	0.147	0.363	0.172	0.195	8.72	0.36
.855	-0.752	0.148	0.358	0.169	0.193	8.73	0.36
542.851	-0.757	0.147	0.361	0.162	0.188	8.74	0.36
.873	-0.758	0.146	0.361	0.163	0.192	8.75	0.36
544.871	-0.748	0.144	0.358	0.160	0.190	8.72	0.36
.906	-0.755	0.150	0.360	0.163	0.196	8.74	0.37
546.858	-0.754	0.146	0.361	0.167	0.198	8.74	0.36
551.820	-0.763	0.145	0.365	0.162	0.195	8.76	0.36

of the reader, the transformation into the Johnson BV system is provided, employing Pel's formula (1976) as well as Table 7 of Walraven, Tinbergen and Walraven (1964). A slight correction term due to the changes in the V-band sensitivity as determined by Lub and Pel (1977) has been added. Our observations do not confirm the variability with the given amplitude during ten nights of monitoring. Thus, the star is not a short-period Cepheid.

NSV 9246 = BV 547 = HD 159654 (F5 Ib): The variability of this star was first noted by Strohmeier, Knigge and Ott (1964). They observed an amplitude of 0.6 m_{pg}. Our data, covering 58 nights and listed in Table III, confirm the

Table III

VBLUW-data for NSV 9246 = BV 547 = HD 159654

JD_{hel}	V	V-B	B-U	U-W	B-L	V_J	$B-V_J$
2445540.653	-0.099	0.306	0.549	0.328	0.286	7.07	0.74
.778	-0.108	0.299	0.525	0.283:	0.278	7.10	0.72
541.646	-	0.358	0.541	0.342	0.306	-	0.86
.759	-0.226	0.375	0.557	0.384	0.352	7.38	0.89
542.666	-0.231	0.367	0.543	0.355	0.335	7.39	0.88
544.784	-0.153	0.340	0.530	0.313	0.307	7.20	0.82
545.546	-0.236	0.378	0.543	0.356	0.346	7.40	0.90
546.537	-0.175	0.336	0.540	0.338	0.310	7.26	0.81
.742	-0.146	0.323	0.546	0.334	0.302	7.19	0.78
547.491	-0.114	0.312	0.555	0.337	0.293	7.11	0.76
.642	-0.123	0.315	0.554	0.340	0.299	7.13	0.76
.683	-0.134	0.319	0.562	0.345	0.306	7.16	0.77
548.502	-0.223	0.368	0.546	0.357	0.341	7.37	0.88
551.518	-0.174	0.349	0.549	0.348	0.321	7.25	0.84
564.533	-0.120	0.317	0.556	0.327	0.305	7.12	0.77
566.499	-0.209	0.355	0.543	0.348	0.328	7.34	0.85
582.495	-0.224	0.373	0.551	0.355	0.349	7.37	0.89
583.611	-	0.342	0.546	0.338	0.319	-	0.82
585.545	-0.208	0.358	0.560	0.353	0.336	7.34	0.86
593.504	-0.218	0.359	0.542	0.328:	0.328	7.36	0.86
596.506	-0.234	0.375	0.547	0.349	0.348	7.40	0.89
597.495	-0.144	0.320	0.545	0.339	0.300	7.18	0.77
598.528	-0.134	0.326	0.555	0.343	0.309	7.16	0.79

variability both in brightness and in colour, indicating Cepheid variation. Our observation are sufficient to deduce preliminary elements using the method of Stellingwerf (1978), namely:

$$JD(max) = 2445540.43 + 3.3825 * E$$
$$\pm.05 \quad \pm.015 \qquad (me)$$

In Figure 1 the Walraven V, V-B and B-U light and colour curves are depicted, phased according to these elements. These light curves show that NSV 9246 is a small amplitude disc population Cepheid, therefore it pulsates in the first harmonic mode.

NSV 11708 = SVS 994 = BD-05°4861 (F5): The first mentioning of a possible variation of this star with an amplitude of one magnitude (photographic) and

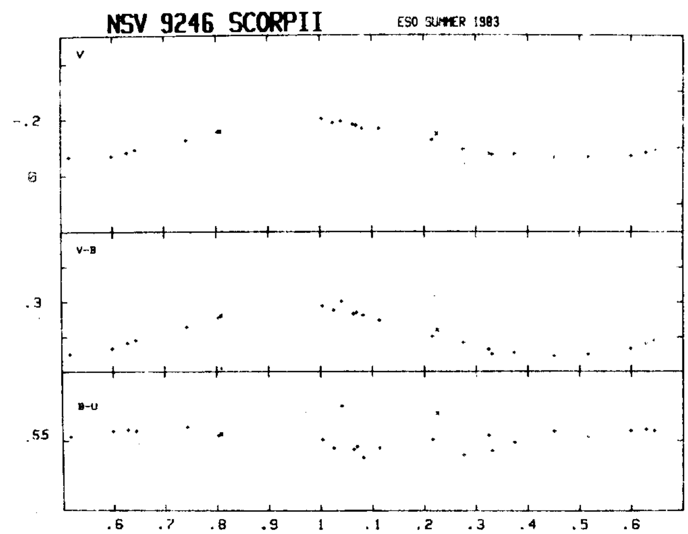

Figure 1

Light and colour curves of NSV 9246 in the Walraven system phased according to the elements JD_{hel} = 2445540.43 + 3.3825 * E

a possible EA classification was provided by Soloviev (1945). Our data as listed in Table IV might lend some support to this classification. A slight decrease of the brightness ($\Delta V \sim 0.1m$) was observed on JD 2445541 during a two and a half hour timespan. The period is probably rather long.

Table IV

VBLUW-data for NSV 11708 = SVS 994 = BD $-05^{o}4861$

JD_{hel}	V	V-B	B-U	U-W	B-L	V_J	$B-V_J$
2445540.701	-1.324	0.259	0.403	0.263	0.240	10.14	0.63
541.670	-1.330	0.263	0.407	0.269	0.235	10.16	0.64
.767	-1.362	0.252	0.423	0.288	0.248	10.24	0.62
542.740	-1.325:	0.265	0.413	-	0.235	10.14:	0.64
544.791	-1.336	0.258	0.414	0.250	0.245	10.17	0.63
546.725	-1.338	0.261	0.412	0.229	0.230	10.18	0.64
547.562	-1.331	0.254	0.421	0.238	0.236	10.16	0.62
551.686	-1.344	0.251	0.416	0.237	0.235	10.19	0.62

NSV 12665 = BV 1477 = HD 189306 (F2): The star was reported to be variable with an amplitude of 0.3 m_{pg} by Strohmeier (1971). Our observations listed in Table V indicate a slight variability by only a few hundredths of a magnitude in V.

Table V

VBLUW-data for NSV 12665 = BV 1477 = HD 189306

JD_{hel}	V	V-B	B-U	U-W	B-L	V_J	$B-V_J$
2445540.771	-0.526	0.190	0.358	0.189	0.212	8.16	0.47
.854	-0.490:	0.187	0.362	0.202	0.212	8.07:	0.46
541.707	-0.524	0.187	0.351	0.190	0.211	8.15	0.46
.773	-0.530	0.194	0.350	0.196	0.213	8.17	0.48
.839	-0.540	0.199	0.369	0.220	0.228	8.19	0.49
542.746	-0.527	0.188	0.352	0.196	0.209	8.16	0.46
.864	-0.524	0.191	0.351	0.194	0.211	8.15	0.47
544.821	-0.524	0.190	0.348	0.200	0.212	8.15	0.47
546.749	-0.524	0.189	0.349	0.194	0.211	8.15	0.47
547.676	-0.523	0.189	0.350	0.194	0.208	8.15	0.47
551.808	-0.533	0.191	0.350	0.192	0.212	8.18	0.47

NSV 14164 = BV 793 = HD 212936 (F5): The last star in our sample was found by Strohmeier, Fischer and Ott (1966) to be variable with an amplitude of 0.4 m_{pg}. The nine observations collected in Table VI show no variability exceeding the internal errors of the measurements. If the star is variable at all, it is probably an eclipsing binary.

Table VI

VBLUW-data for NSV 14164 = BV 793 = HD 212936

JD_{hel}	V	V-B	B-U	U-W	B-L	V_J	$B-V_J$
2445541.749	-1.066	0.176	0.350	0.183	0.206	9.51	0.44
.814	-1.070	0.170	0.342	0.178	0.208	9.52	0.42
.863	-1.064	0.169	0.350	0.175	0.207	9.51	0.42
542.753	-1.059	0.168	0.344	0.170	0.201	9.49	0.42
.869	-1.061	0.170	0.338	0.182	0.195	9.50	0.42
544.867	-1.060	0.165	0.334	0.164:	0.194	9.50	0.41
.912	-1.066	0.172	0.338	0.180	0.196	9.51	0.43
546.853	-1.070	0.173	0.346	0.188	0.208	9.52	0.43

We would like to express our gratitude towards the directorate of the European Southern Observatory for the allotment of observing time on the Dutch telescope at La Silla, Chile. Furthermore it is a pleasure to thank

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R. DIETHELM

Astronomisches Institut der Universitaet
Basel, Venusstrasse 7
CH-4102 Binningen/Switzerland

S. TJEMKES

Sterrenkundig Instituut "Anton Pannekoek",
Roeterstraat 15, 1018 wb Amsterdam,
The Netherlands

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ON THE PERIOD-LUMINOSITY RELATION FOR DELTA SCUTI STARS

In our previous paper (Frolov, Irkaev, 1982) different parameters for Delta Scuti stars in open clusters were given, in particular, reliable luminosities based only on cluster membership. In Table I we give for each variable the

Table I

Praesepe (A_V=0)	lg P	M_V	B-V	$(B-V)_o$	b-y	$(b-y)_o$
BR Cnc = KW 45	-1.420	2.06		0.231		0.131
BS Cnc = KW 154	-1.292	2.31		0.251		0.149
BU Cnc = KW 207	-1.276	1.48		0.197		0.104
BN Cnc = KW 323	-1.409	1.60		0.224		0.130
BQ Cnc = KW 292	-1.131	1.98		0.304		0.198
BW Cnc = KW 340	-1.143	2.28		0.259		0.147
BX Cnc = KW 445	-1.276	1.77		0.208		0.120
BY Cnc = KW 449	-1.237	1.72		0.201		0.115
Pleiades (A_V=0.06)						
V 534 Tau=HII 1266	-1.495	2.57	0.36	0.34	0.229	0.214
V 624 Tau=HII 158	-1.699	2.80	0.235	0.215	0.149	0.134
V 647 Tau=HII 1362	-1.328	2.40	0.26	0.24	0.153	0.138
V 650 Tau=HII 1425	-1.509	2.08	0.153	0.133	0.090	0.075
Coma (A_V=0)						
FM Com=HR 4684	-1.260	1.89		0.181		0.099
Hyades (A_V=0)						
υ_2 Tau=VB 60	-0.876	1.00		0.268		0.165
θ^2 Tau=VB 72	-1.097	1.56		0.179		0.099
ρ Tau=VB 95	-1.174	1.37		0.240		0.144
V 480 Tau=VB 123	-1.377	1.81		0.21		0.122
V 483 Tau=VB 30	-1.268	2.29		0.278		0.170
V 696 Tau=VB 33	-1.444	1.94		0.223		0.126
V 775 Tau=VB 38	-1.208	2.43		0.320		0.196
V 777 Tau=VB 141	-0.790	1.19		0.253		0.150
α Per (A_V=0.30)						
V 459 Per=H 501	-1.432	2.90	0.351	0.251	0.212	0.138
V 461 Per=H 606	-1.456	2.74	0.330	0.230	0.207	0.133
V 465 Per=H 906	-1.523	2.54	0.276	0.176	0.167	0.093
NGC 7789 (A_V=0.84)						
V 521 Cas=K 573	-0.833	1.56	0.64	0.36		

colour-indices (B-V) and (b-y) from various sources and reddening free ones, M_V and P values were taken from our cited paper. $(B-V)_o$ and $(b-y)_o$ were calculated on the basis of absorption values A_V for each cluster according to our cited paper and the following relations:

$E_{B-V} = 1/3\ A_V$, $E_{b-y} = 0.74\ E_{B-V}$ (Crawford, Mandwewala, 1976).

Using the least squares solution we have calculated both the PL and the PLC relations for cluster Delta Scuti stars. Two unusual variables in NGC 2264, V 588 Mon = W2 (A7 III-IV) and V 589 Mon = W 20 (F2 III), may still be at gravitational contraction phase, and the evolved giant BT Cnc=KW 204 (F0 III) in Praesepe were not used either. Therefore, these relations were obtained practically only for main-sequence variables of the Delta Scuti-type:

$$M_V = \underset{\pm 0.34}{-1.66}\ \lg P \underset{\pm 0.44}{-\ 0.11},\quad \sigma_o = \pm 0.37,$$

$$M_V = \underset{\pm 0.32}{-2.06}\ \lg P + \underset{\pm 1.32}{4.14}\ (B-V)_o \underset{\pm 0.61}{-1.61},\quad \sigma_o = \pm 0.31,$$

$$M_V = \underset{\pm 0.35}{-2.02}\ \lg P + \underset{\pm 2.09}{5.39}\ (b-y)_o \underset{\pm 0.60}{-1.33},\quad \sigma_o = \pm 0.33.$$

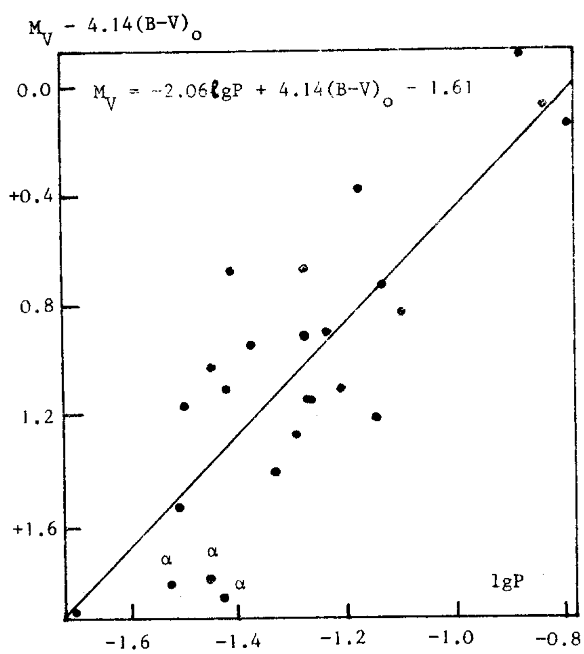

Figure 1

For V 521 Cas = K 573 in NGC 7789 M_V = +1.56 and P = $0^d.147$ were taken from Breger (1983), this star was not used for the P-L-$(b-y)_0$ relation due to absence of (b-y) -observations. The second relation is shown in Figure 1.

We note that co-efficients for lg P in all our relations are much smaller than the co-efficient -3.052 of the Breger's PLC relation (Breger, 1979), which was derived by the maximum - likelihood method. Our coefficients for $(b-y)_0$ and $(B-V)_0$ are also smaller compared with 8.456 (Breger, 1979) and 5.285 (Halprin, Moon, 1983), correspondingly.

We feel that the reason for this difference is not only an effect of different method used but it indicates the reality of a smaller slope of the PL and PLC relations for main-sequence pulsators compared with the bulk of Delta Scuti variables. We have calculated the value of $\sigma_0 = \pm 0.40$ for open cluster Delta Scuti stars with the Breger's PLC relation which is indeed larger than that for our relations.

It is of interest to note that all the α Per cluster variables, i.e. the youngest objects, lie below the line of our PL and PLC relations (these stars are marked in the Figure 1 by symbols "α").

M.S. FROLOV

Astronomical Council of the
USSR Academy of Sciences
48, Pjatnitskaja str.
Moscow 109017, USSR

B.N. IRKAEV

Dushanbe Astrophysical Institute
of Tadjik Academy of Sciences
22, Sviridenko Str.
Dushanbe 734670, USSR

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AN APPLICATION OF WESSELINK'S MODIFIED METHOD TO THE DETERMINATION OF MEAN RADII OF RV TAURI STARS

The observational evidence favouring the existence of strong shock waves (SW) in the atmospheres of RV Tau stars is overwhelming. We have calculated the mean radii of AC Her ($P=75^{d}.46$) and V Vul ($P=75^{d}.72$) by Wesselink's modified method (Batyushkova, 1981, 1982) with shock radiation effect on light and colour curves being taken into account. It should be noted that the earlier attempts to apply the Wesselink's method to the determination of radii of RV Tau stars had failed (Du Puy, 1973).

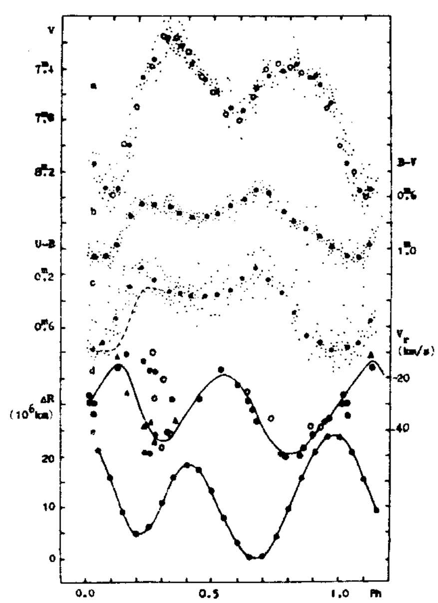

Figure 1

The mean normal V, B–V, U–B light and colour curves of AC Her, and the radial velocity and the radius displacement curves of AC Her (the explanation of the signs are given in the text).

For the first time the mean normal light and colour curves of AC Her (Figure 1 a,b,c) have been plotted with all accessible photoelectric UBV observations (Eggen, 1961, Preston et al., 1963, Du Puy, 1973, Dawson, 1979, Nakagiri and Jamashita, 1979, Zubarev, Kayumov, Rahimov, Chernova, to be published). The adequate stability of these curves and coincidence of different authors' photometric systems were deduced. The mean square errors of normal points (big dots), calculated through $\approx$ 0.05P interval are about $\bar{\sigma}_V = \pm 0\overset{m}{.}03$, $\bar{\sigma}_{B-V} = \pm 0\overset{m}{.}02$, $\bar{\sigma}_{U-B} = \pm 0\overset{m}{.}04$.

The radial velocity curve (Figure 1c) of AC Her was plotted on Sanford's (1955) and Du Puy's (1973) observations with dispersion of 10 Å/mm and 12 Å/mm (marked by dots and open circles, respectively). This is also in a full accord with Baird's data (1982). The Fe neutral lines have been used but the H emission lines (marked by triangles) as well as the violet absorption components at phases of spectral peculiarities have been preferred as being formed more closely to the stellar photosphere (Baker et al., 1971, Hill and Willson, 1979).

The mean radii of the stars were computed by our own program. The dashed line on the U-B colour curve (Figure 1c) shows $(U-B)^{*}$ magnitudes, which are in accordance with the phases of equal B-V. The V band shock radiation excesses ΔV have been calculated and the V light curve has been corrected for the SW emission by using the relation

$$\Delta V = K\ \Delta(U-B)$$

Here the colour excess $\Delta(U-B) = (U-B) - (U-B)^{*}$ is due to the SW emission and the value k is assumed to be 0.6 (Batyushkova, 1981, 1982).

The systemic velocity of the star $V_\gamma = -32{,}8$ km/s was determined. Then the radial velocity curve was integrated and the radius displacement curve has been obtained (Figure 1e). It is obvious that the star is compressed and extended twice during a pulsation period. The main minimum of the displacement curve occurs at phase 0.57P, the secondary one at phase 0.11P. The radius displacement reaches its maximum amplitudes $\Delta R = 24.19 \cdot 10^6$ km at phase 0.88 P, the secondary maximum occurs at phase 0.31P.

Then we calculated the mean radii of the star assuming that the phase shift between light and radial velocity curves was changed from $\Delta\varphi = -0.1$P to $\Delta\varphi = +0.1$P with 0.01 P interval. A well known formula

$$\bar{R} = \frac{\Delta R_2 - n\Delta R_1}{n - 1}$$

was used, where

$$n = 10^{0.2(m_1 - m_2)}$$

ΔR_1 and ΔR_2 are the displacements from the mean radius, m_1 and m_2 are the V corrected light magnitudes at phases of equal B-V.

It turned out that the minimum mean square error $\sigma = 1.7 \cdot 10^6$ km is corresponding to the mean radius $\bar{R} = 44.5 \cdot 10^6$ km with the phase shift $\Delta\varphi = -0.03P$ (28 phase pairs have been used). Such shift exists (Figure 1) between the minimum of the light curve and the maximum of the compression velocity. The problem of phase matching will be regarded in another paper.

The knowledge of the mean radius $\bar{R}$, the availability of the displacement curve ΔR and the colour curve B-V make it possible to calculate the relative amplitudes of the light changes at each phase by the formula:

$$\Delta m = -5 \lg \frac{R_2}{R_1} - 10 \lg \frac{T_2}{T_1} - \Delta BC$$

where R_1 and T_1 are the radius and the temperature at light minimum, R_2 and T_2 are the same ones at any other phase, ΔBC is the difference between bolometric corrections at phases in question. The effective temperature scale was derived by the averaged relations of Böhm-Vitense (1973), Kurucz (1979) and Traat and Malyuto (1981) for the stars with decreased metal content. The colour excess $E_{B-V} = 0\overset{m}{.}4$, which is caused by the interstellar and circumstellar absorption (Baird, 1981) was taken into account. The results of the calculations are shown in Figure 1a (open circles). The coincidence between the calculated amplitudes and the observed ones is quite satisfactory and it may justify our method.

The photoelectric UBV observations by Preston et al., (1963), Du Puy (1973), Zubarev, Kayumov, Chernova (Dushanbe, to be published) and the radial velocity curve by Sanford (1931) with the dispersion of 70 Å/mm are accessible for V Vul. Because of the absence of high dispersion observations for V Vul, a comparison between the radial velocity curves of AC Her and V Vul was made. It turned out that they are very close and this is not surprising, because the periods of both stars are nearly the same and their light curves have similar amplitudes. So the velocity curve of V Vul was plotted as that of AC Her at phase 0.0 + 0.2 P. The mean radius $\bar{R} = (45.9 \pm 2.2) \cdot 10^6$ km was determined by the above method, 19 phase pairs being used.

The mean absolute magnitudes $M_V = -4\overset{m}{.}34$ and $M_V = -3\overset{m}{.}98$ for AC Her and V Vul, respectively were calculated (E_{B-V} for V Vul was assumed to be equal to that for AC Her). This is in accordance with Du Puy's (1973) P-L relation and places these stars on the H-R diagram in the domain of RV Tau stars. A more detailed account of this work will be presented elsewhere.

B.N. BATYUSHKOVA

Astrophysical Institute of Tadjik
Academy of Sciences,
22, Sviridenko str.
Dushanbe 734670, USSR

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o And: A PUZZLE WHICH CAN BE RESOLVED

Analyzing records of the spectral behaviour of o And (1 And, HR 8762, HD 217675-6, BD+41°4664) since 1890 which I found in the astronomical literature as well as many sets of photoelectric observations of the star obtained by various authors since 1915 (with the exception of as yet unpublished data secured by several groups of observers during the on-going international observing campaign), I arrived at the following preliminary conclusions:

1. Photometric variations of o And arise from a superposition of the following variations:

i. Long-term variations with an amplitude of about 0.1^m in V and B characterized by relatively narrow minima and flat maxima. At maximum light, $V \doteq 3.61^m$ and $B \doteq 3.50^m$. There is a strong suspicion that these long-term variations are periodic, with a period of about 3100 days (i.e. 8.5 years).

ii. Rapid truly-periodic variations with a period of 1.571272 days, characterized by a light curve with two unequal minima and maxima and by variable amplitude and shape. These variations almost disappear in the maxima, and have the largest amplitude (of roughly about 0.1^m) in the minima of the long-term changes. A preliminary epoch of the (usually deeper) minimum is HJD 2429981.250.

iii. Further analyses, and probably further observations, are needed to see if there is some regularity in the variations of the shape of the 1.571-day light curve. There is a suspicion that a characteristic time scale of such changes is 11-15 days.

2. The minima of the long-term light variations coincide well with the presence of the hydrogen shell lines in the spectrum of o And. The recorded hydrogen- shell episodes seem also to occur with the 3100-day periodicity. If these long-term variations are indeed periodic, then it is probable that the shell episodes and the accompanying long-term light variations are somehow connected with the orbital motion of the closer visual companion to o And discovered

probably by Wilson (1950) and re-discovered by Blazit et al. (1977). The observed angular separation of the pair and the observed parallax of o And are in excellent agreement with an 8.5-year orbital period.

3. Considering the shape of the light curve and the fact that all the light variations represent light decreases from a stable maximum level, it seems more probable that the rapid light variations of o And are caused by some density inhomogeneities carried across the disk of the star by its rotation as suggested by Harmanec (1984 a,b) not by non-radial pulsations as proposed by Vogt and Penrod (1983). It is tentatively suggested that the model of "rotating spokes", also considered (and refuted) for Zeta Oph by Vogt and Penrod may provide a better representation of the data. Strange rapid profile variations of the Mg II 4481 line are known for o And for a long time (for the best available description see Gulliver et al., 1980). I tentatively propose that the density inhomogeneities could be connected with the presence of a magnetic field and that the "spokes" considered by Vogt and Penrod could in fact be some density enhancements along the magnetic lines of force. The presence of such spokes could cause rather complicated radial-velocity variations which could explain the failure of the attempts to find some regularity in the rapid radial-velocity changes observed. The material forming the shell and/or these density enhancements could come from the visual secondary component of o And, in agreement with the general binary hypothesis of the Be phenomenon as reformulated by Harmanec (1982).

A detailed study with full analyses of the data will soon be submitted for publication in Bull.Astron.Inst.Czechosl. I publish this note as an urgent appeal to all Be-star observers: o And now appears to be an ideal object for a concentrated international effort which could lead to a rapid and substantial progress in our understanding the Be phenomenon. In particular, I stress the importance of the following kinds of observations:

1. Monitoring of the Mg II profile, Ca II K profile, He I profiles and the H alpha profile with the signal-generating detectors in different phases of the 1.571-day period and in different phases of the long-term cycle.

2. Attempts to detect a possible magnetic field of o And, and - in the case of detection - measuring its variations over the 1.571-day period.

3. Continuing photoelectric observations of the star, including the IR and UV light curves of the 1.571-day period, which could help in further restriction of possible models.

4. Optical spectroscopy should answer two questions:

a. whether or not the metallic shell spectrum and the H alpha emission occur always at maximum of the hydrogen shell or whether they behave in a different manner, and

b. whether the occurrence of the shell phases is indeed a periodic, or only a cyclic phenomenon.

5. Polarimetric observations over the 1.571-day cycle.

P. HARMANEC

Astronomical Institute
Czechoslovak Academy
of Sciences
251 65 Ondřejov
Czechoslovakia

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PHOTOELECTRIC OBSERVATIONS OF 1 Per AND BU Tau

The two variable stars have been observed in the V-band with a 165/1430 newtonian telescope. The phases of 1 Per were calculated with the elements from Poretti (1982):

$$\text{Min I} = \text{JD } 2443562.853 + 25\overset{d}{.}9359 \times E \qquad (1)$$

Distinct minimum could only be observed at phase 0.41.

<u>1 Per</u>

ΔV are in the sense 4 Per minus 1 Per

4 Per (5.007 V, B8V)

Hel. J.D. 2440000 +	Phase	ΔV	Hel. J.D. 2440000 +	Phase	ΔV
5638.275	0.026	−0.53	5671.217	0.291	−0.57:
5645.279	0.290	−0.47	5673.304	0.368	−0.49
5647.238	0.367	−0.50	5689.213	0.985	−0.42
5648.229	0.405	−0.61	5691.221	0.062	−0.54
5648.279	0.407	−0.63	5751.321	0.380	−0.58:
5651.250	0.521	−0.48	5752.292	0.414	−0.71
5652.238	0.560	−0.50	5759.300	0.688	−0.49
5661.254	0.907	−0.56	5778.292	0.420	−0.67
5663.203	0.983	−0.48	5779.283	0.459	−0.50:
5663.233	0.984	−0.46	5780.279	0.497	−0.52

The variable BU Tau was in maximum light during the observing time. There were small amplitude variations present.

BU Tau

comparison star: 16 Tau (5.46 V, −0.04 (B−V))

check star: 19 Tau (5.65 V, −0.07 (B−V))

Hel. J.D. 2440000 +	V	Hel. J.D. 2440000+	V	Hel. J.D. 2440000+	V
5346.29	5.10	5645.27	5.20	5691.29	5.17
5406.29	5.13	5647.27	5.22	5705.29	5.16:
5407.30	5.13	5651.30	5.21	5744.25	5.17
5430.31	5.13	5663.25	5.25	5751.29	5.24:
5617.37	5.20	5683.26	5.13:	5759.29	5.23
5621.32	5.25:	5684.28	5.15:	5778.31	5.15
5638.25	5.11:	5689.26	5.22	5780.31	5.13

D. BÖHME

4851 Nessa 11 Pf.: 93
German Democratic Republic

Reference:

Poretti E., 1982, I.B.V.S. No. 2239

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VARIABLE LINE STRENGTHS OF STAR HD 50896

Wolf-Rayet stars form a distinct class of stellar objects and have spectra in which emission lines of either nitrogen and helium predominate (WN) or else emission lines of helium, carbon and oxygen predominate (WC). Furthermore, these stars suffer mass loss through strong stellar winds. Their evolutionary status is also of significant interest since these objects are suspected to be supernovae precursors. Also, in case of 'Of' and W-R stars, the mechanisms responsible for mass loss are not completely understood. It is also not clear whether these objects are pre-or post-main sequence stars (cf., Kitchin, 1982).

In some W-R stars it has been found that the emission line strengths show temporal variations. Attempts have been made to explain such variability on the basis of binary hypothesis which attributes the emission line strength variations to fluctuations in gas streams in and around the members of a close binary system. Alternatively, the pulsation hypothesis has been used which ascribes these variations in line strengths to the presence of pulsational instability of massive carbon burning cores of evolved objects.

HD 50896 is one amongst the brightest Wolf-Rayet stars ($V = 6^{m}_{.}9$). Its spectral type is WN 5 (Smith, 1968, 1973) and the star appears to be the central object of the faint ring nebula S308 having a diameter of 35 arc minutes. Previous investigators drew attention to the variation in the emission lines of this star but did not find any periodicity.

Brucato (1971) published sets of photographic survey of line strengths in nine 'Of' stars and reported the evidence of variability in most of the selected stars. Recently, some evidence has also been advanced indicating that the emission line strengths in these objects may show short period fluctuations (Weller and Jeffers 1979). Bhang (1975) published photoelectric line profiles of W-R stars and reported the variations in the profiles of emission lines. Weller and Jeffers (1979) reported similar short term variability in strengths of emission lines for some W-R stars including that of HD 50896. Fermani et al. (1979, 1980) derived a period of $3^{d}_{.}763$ from spectral and photometric variations observed for this star. The period was later confirmed by McLean (1980) and by Cherepashchuk (1981). Here we report our findings of marked variations in the emission line strengths of HD 50896.

The star HD 50896 was observed with a view to monitor the variability of different emission lines in the visible region. We secured 11 spectrophotometric scans of the star on 13th February, 1984 over a time span of nearly 1.5 hours. The star was observed with a Hilger and Watts monochromator at the Cassegrain focus of the 104-cm telescope at Uttar Pradesh State Observatory, Naini Tal. The disperison at the exit slit of the monochromator was 70 Å/mm. The scans were obtained with an exit slit of 0.7 mm admitting 50 Å of the spectrum.

Figure 1 shows the time variations of the observed strengths of different emission lines for HD 50896. The emission lines chosen are λ4097(NIII)-λ4103(HeII), λ4339(HeII), λ4859(HeII), λ5411(HeII), λ6560(HeII) and λ7065(HeI).

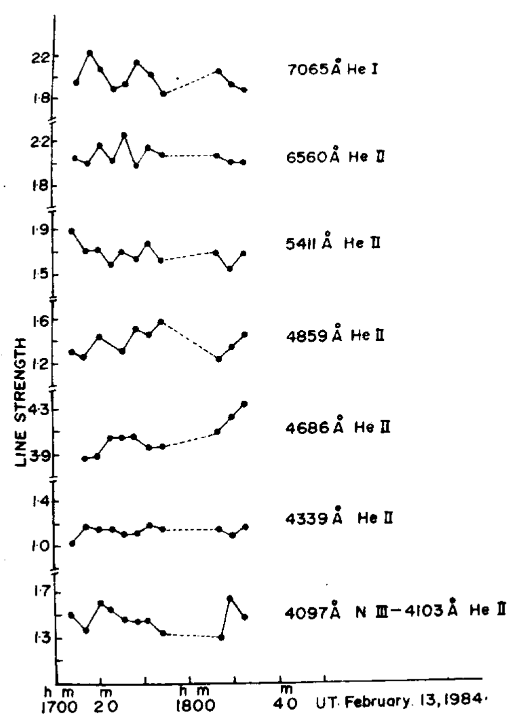

Figure 1

Observed variation in line strengths of star HD 50896

For each line, the line strength has been defined as (Intensity of line)/(Intensity of continuum). It is clear that there are large variations in line strengths of the chosen emission lines. The variability is of the order of 0.2 for λ4686(HeII) line which is the strongest one. For a few emission lines the characteristic duration of variability (max-min-max) ranges between 20 to 25 minutes. However, this pattern does not repeat itself for all the emission lines. To confirm it, a few more observations are necessary.

These emission line strength variations may favour the presence of pulsational instability possible if the star is evolved and has a massive carbon burning core. Alternatively, one may surmise that the star may be a binary system. The large variations of line to continuum ratio (line strength) and the absence of absorption lines favour a low mass companion. The large height above the galactic plane and the low mass of the companion supports the idea that the star HD 50896 may be a companion star in a binary system.

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MAHENDRA SINGH

Uttar Pradesh State Observatory,
Manora Peak,
Naini Tal-263 129
India

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EPSILON AURIGAE: B V R I J H K PHOTOMETRY

We have made photometric measurements of the peculiar binary system ε Aurigae at a number of epochs during the current eclipse. The B,V,R,I measurements were made with a 14" Celestron telescope using a solid state photometer from Thaltej near Ahmedabad ($23^{o}03'$ N, $72^{o}30'$ E). Measurements in the infrared J, H, K bands were made with the 40" telescope of the Uttar Pradesh State Observatory at Nainital using a liquid nitrogen cooled InSb photometer. Results are listed in Table I.

Table I

Epsilon Aurigae: Photometry

Date	B	V	R	I	J	H	K
March 15, 1982	3.46	3.06	-	-	-	-	-
Feb. 7, 1983	-	-	-	-	2.45	2.22	2.11
Nov. 26, 1983	-	-	-	-	2.35	2.09	2.01
Jan. 16, 1984	4.30	3.68	3.15	2.70	-	-	-
Jan. 30, 1984	4.39	3.78	3.22	2.76	-	-	-
Feb. 10, 1984	4.33	3.73	3.19	2.68	-	-	-
Feb. 12, 1984	4.35	3.66	3.15	2.71	-	-	-
Feb. 25, 1984	4.39	3.60	3.13	2.64	-	-	-
March 1, 1984	-	-	-	-	2.36	2.11	-
March 5, 1984	4.40	3.65	3.07	2.65	-	-	-
Apr. 7, 1984	-	3.22	2.74	2.34	-	-	-

Errors in the magnitude measurements in all the filters are of the order of 0.05 mag.

We note from Table I that the eclipse depths in the infrared are similar to those in the visible and the third contact occurred much later than the predicted date January 9, 1984. These results are in agreement with those reported in Hopkins and Stencel (1984).

H.C. BHATT, N.M. ASHOK and T. CHANDRASEKHAR

Physical Research Laboratory
Ahmedabad-380009, India

Reference:

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INFRARED PHOTOMETRY OF R CrB

R CrB is the prototype of a class of irregular variables that are characterized by an overabundance of carbon and undergo sudden decreases in visual brightness at irregular intervals. During the minima the decrease in brightness in the near infrared is less than that in the visible. In the L band (3.4 μm) R CrB shows variations unrelated to the sudden visual drops. Strecker (1975) found L magnitude variations for R CrB on a time scale of about 1100 days. However, whether these variations are periodic is not known.

We have observed R CrB in the J, H, K, L bands (at 1.2, 1.6, 2.2, 3.4 μm, respectively) on three occasions including one (March 6, 1984) during the current minimum. Observations were made with the 104 cm telescope of the Uttar Pradesh State Observatory at Nainital using a liquid nitrogen cooled InSb photometer. The measured J, H, K, L magnitudes are listed in Table I, wherein the measurements by Glass (1978) and Shenavrin et al. (1979) are also given.

Table I

R CrB: Infrared photometry

Date	J	H	K	L	visual phase	References
Feb. 1 to 12, 1975	5.04	4.82	4.26	2.62	bright	Glass (1978)
June 1,1977	-	7.22	5.27	2.91	faint	Shenavrin et al.(1979)
Feb. 18,1980	5.10	4.80	4.10	2.20	bright	present work
March 25,1980	5.10	4.80	4.10	2.30	bright	present work
March 6,1984	8.15	6.61	4.93	-	faint	present work

The four new measurements in the L band made subsequent to the observations of Strecker (1975) do not fit a periodic extrapolation of the L light curve for R CrB given by Strecker (1975). It is not clear whether the low L brightness during the 1977 visual minimum is related to the drop in the visible light or is a part of an independent long term variation in the L band.

N.M. ASHOK, T. CHANDRASEKHAR and H.C. BHATT
Physical Research Laboratory
Ahmedabad-380009, India

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AUTOMATIC PHOTOELECTRIC TELESCOPE: FOURTH QUARTER 1983 OBSERVATIONS

The Automatic Photoelectric Telescope at Fairborn Observatory West in Phoenix, Arizona began operation on the night of 12-13 October 1983. Photometry from this date through the end of 1983 was confined to a small test program of 29 groups of stars, with each group consisting of a variable, a comparison star, a check star, and a sky position. During this time 1352 group observations were made. Since each group observation consisted of a sequence of 33 different 10-second observations, there was a total of 44616 observations. Beginning with the first day of 1984, the observing program was expanded to include 71 groups.

Automatic photoelectric telescopes in general have been discussed by Boyd and Genet (1983). The details of the 25-cm telescope at Fairborn Observatory West and its computerized electronic operating system are given by Boyd, Genet, and Hall (1984). Specifics on the mechanics of the mount and drive are given by Boyd, Genet, and Trueblood (1984). And a complete listing of the software is provided by Trueblood and Genet (1984).

The individual differential magnitudes have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars, where they are available (Breger, 1982) as File No. 131, which contains three parts. Part I is a summary of the contents of the file. Part II is a listing of detailed information on the 29 groups of stars observed. Part III contains the actual observational results. Data on specific variables can be requested, if the entire contents of the file are not needed.

Table I lists the 29 groups observed. The first column is the group number. The second is the group name. The third is the number of times the group was observed during the quarter. And the last is the number of pages of reduced data in File No. 131. Most of the 29 groups contain an RS CVn-type binary, either known to be or suspected of being photometrically variable. Six (18, 24, 25, 26, 27, 28) are semi-regular variables. Three (5, 16, 23) are red-blue star pairs used to determine our transformation coefficients. One (R Sct) is an RV Tau variable. One (59 d Ser) is a variable of unknown type. One (5 Cet) is a recently discovered long-period giant eclipsing binary. And the last is the familiar epsilon Aur.

TABLE I

The 29 Groups Observed

number	group name	number of observations	number of pages
1	lambda And	60	2
2	39 AY Cet	36	1
3	sigma Gem	73	3
4	V711 Tau	96	3
5	27 & 28 LMi	51	2
6	HR 9024	58	2
7	HR 7428	23	1
8	IM Peg	61	2
9	HR 7275	34	2
10	HR 6469	4	1
11	DK Dra	15	1
12	R Sct	2	1
13	12 BM Cam	93	3
14	33 Psc	63	2
15	5 Cet	40	2
16	HD 210419 & 210434	43	2
17	59 d Ser	1	1
18	FS Com	15	1
19	HK Lac	51	2
20	AR Lac	45	2
21	29 Dra	1	1
22	53 UMa B	0	0
23	51 & 52 Aur	81	3
24	CE Tau	76	3
25	TV Psc	45	2
26	RZ Ari	81	3
27	rho Per	108	3
28	IN Hya	13	1
29	epsilon Aur	83	3

TABLE II

Sequence of 10-Second Integrations Within a Group

	U	B	V
check	1	2	3
sky	4	5	6
comparison	7	8	9
variable	10	11	12
comparison	13	14	15
variable	16	17	18
comparison	19	20	21
variable	22	23	24
comparison	25	26	27
sky	28	29	30
check	31	32	33

TABLE III

Coefficients Used in Data Reduction

	U	B	V
k'	$0^{m}.77$	$0^{m}.47$	$0^{m}.36$
k"	$-0^{m}.036$	$-0^{m}.036$	$0^{m}.0$
ε	+0.01	-0.05	-0.05

Table II specifies the sequence in which the 33 10-second integrations were made for each group.

Table III contains the values of the extinction coefficients (both primary and color-dependent) and the transformation coefficients used to reduce the photometric data.

Part II of File No. 131 contains the information on each group needed by the Automatic Photoelectric Telescope to locate the group and make the photometric measurements. First: the group name, usually the name of the variable or suspected variable in the group. Second: the diameter of the diaphragm used, in seconds of arc; the three choices available were 45, 60, and 90 arcseconds. Third: the HD number of the variable, comparison, and check star. Fourth: the equatorial coordinates (epoch 2000) of those three stars and the sky position, which usually was midway between the variable and the comparison. Fifth: the approximate V magnitude of those three stars, which was used by the telescope to locate the star and confirm the identification.

Part III of the file contains the fully reduced differential magnitudes, corrected for differential atmospheric extinction and transformed differentially to the UBV system. As the sequence in Table II shows, the variable was bracketted three times by comparison star measures. The resulting three differential magnitudes are listed separately, for each of the three bandpasses. Also the mean of those three and the (internal) error of that mean is listed, for each bandpass. If any group observation yielded a mean error greater than 0.02 magnitude, the results were discarded and hence do not appear in the file; this was the mechanism whereby bad photometric data (resulting from thin clouds and/or faulty centering in the diaphragm) were purged. The entry "check-minus-comp" is simply the difference between the average of the (two) check star measures and the average of the (four) comp star measures. Since there was no purging in this case, a few of these check-minus-comp values will appear discordant, generally as a result of faulty centering of the check star. The heliocentric Julian date refers to the middle of the three variable stars observations. The phase has been computed with the ephemeris specified at the top of each page in the file, unless no ephemeris was available.

Often a group was observed more than once on the same night. This happened naturally as a result of commands issued by the operating system, which is programmed to control the telescope in such a way as to make maximum use of available observing time and to obtain maximum coverage of all stars above the horizon at some time during the night.

LOUIS J. BOYD
Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET
Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL
Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

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INFRARED OBSERVATIONS OF EPSILON AURIGAE

In the night of Dec. 14, 1983, ε Aur and six other stars were observed with TIRGO, a 1.5-m telescope installed on the Gornergrat (Switzerland). A circular variable filter and an InSb photocell permit observations in 37 steps between λ = 2.84 and 4.20 μm. After having allowed for the transmittance of the filters and assuming a constant quantum efficiency of the cell in this range of wavelengths, the observations of the six stars were then compared with Planckians calculated according to a colour-T_{eff} calibration (Böhm-Vitense 1981), thus a normalized mean atmospheric transmittance curve was deduced (Figure 1). For the reduction to an international system, available L magnitudes were collected from the literature and the following reduction

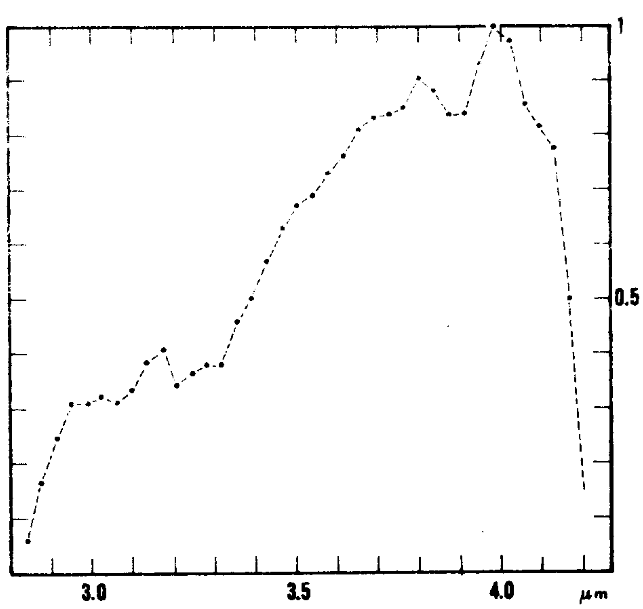

Figure 1

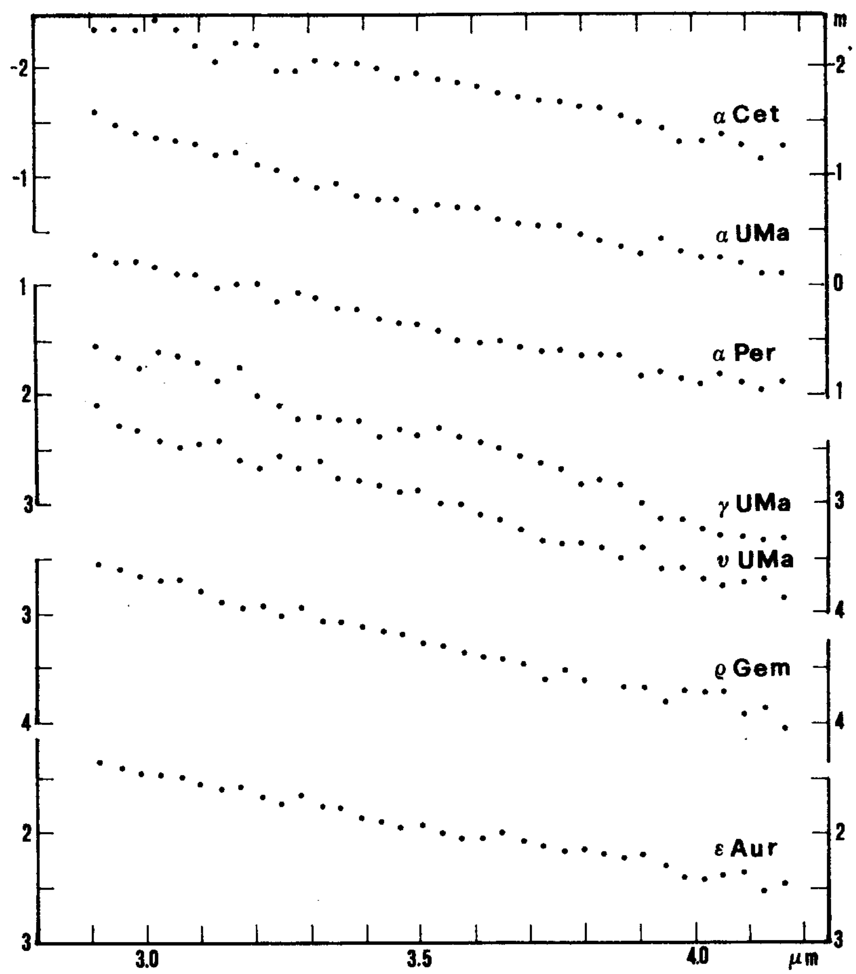

Figure 2

formula was used 8.26-2.5 log l, l corresponds to the counts corrected for the transmittance of filters and atmosphere. All stars were observed around their upper culmination. The arithmetical mean of all observations for each star, between 2.91 and 4.17 μm (central wavelength: 3.54 μm) are given in Table I, whereas the single reduced points are plotted in Figure 1. When the same procedure was applied to ε Aur, the observed values did not fit any Planck function for temperatures corresponding to its spectral type. After some attempts, two Planckians were adopted. The first was related to the spectral type of ε Aur and the other remained unchanged around a temperature of 700^{o}K

Table I

L magnitudes

Star	Sp.type	this paper	other values	References
α Cet	M1.5III	−1.85	−1.74;−1.78;−1.87	Johnson et al. 1966, Lee 1970, Glass, 1974
α Per	F5Ib	+0.37	+0.48	Low and Mitchell, 1965, Johnson et al. 1966
ρ Gem	F0V	+3.27		
υ UMa	F0IV	+2.99	+2.98	Glass 1975
α UMa	K0III	−0.78	−0.78	Johnson et al. 1966
γ UMa	A0V	+2.44	+2.4	Woolf et al. 1970
ε Aur	F2Ib	+1.95	+1.25;+1.23	Low and Mitchell, 1965 Johnson et aL 1966

even changing the stellar temperature between 7200°K and 6740°K. The fit was satisfactorily good and the mean arithmetical magnitude 1.95 resulted, with a fitting error of $\pm$0.04. Since the magnitude out eclipse is 1.25 (see Table I), the decrease within eclipse would be 0.7 magnitudes, which corresponds to 52% of the total magnitude of ε Aur. But, according to our model, the star still contributes for about 80% to the luminosity during eclipse and the remaining flux should come from the eclipsing body.

We wish to thank for the hospitality the Centro per l'Astronomia Infrarossa and in particular Miss Leslie Hunt for the assistance during the observations.

C. BOEHM
Osservatorio Astronomico
Trieste,Italy

B. CESTER
Università degli Studi
Trieste,Italy

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THE PHOTOMETRIC BEHAVIOUR OF DR TAURI IN THE SEASON 1983/84

The star was measured in B on the basis of the given sequence of comparison stars (Götz, 1982) on 36 plates (ORWO-ZU21 + GG13 + BG12) from 29 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory covering the time interval between 1983 August 15 and 1984 March 23. The measurements and the light curve, which is given in Figure 1, are used to complete and to

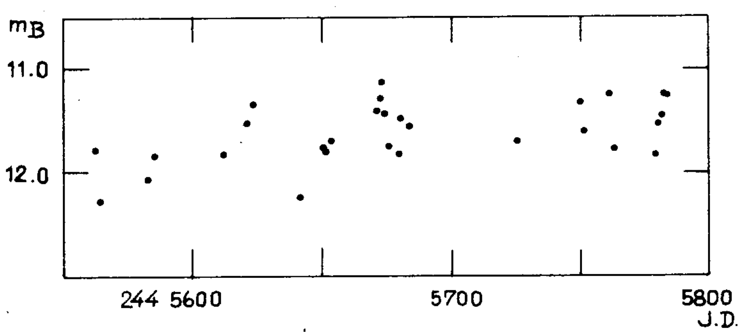

Figure 1

supplement the already known behaviour (Götz, 1980, 1982, 1983) of this star.

In comparing the given light curve with that obtained in former years we can state that DR Tauri has obviously retained its mean brightness. The expectation that the amplitude of the star became smaller in the last seasons could be confirmed.

W. GÖTZ

Akademie der Wissenschaften
der DDR Zentralinstitut für
Astrophysik, Sternwarte
Sonneberg

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ADDITIONAL VARIABLE STARS IN THE NORTHERN LUMINOUS STARS CATALOGUES

In IBVS No. 2112 (March 1982) the writer listed the stars in the six catalogues of Luminous Stars in the Northern Milky Way that were then known to him to be named or numbered suspected variables. With the publication of the New Catalogue of Suspected Variable Stars it has proved desirable to reinvestigate this matter, with the results given in Table I, which lists additional stars that have been newly catalogued as suspected variables and also contains a number of named variables that were overlooked in the previous work.

TABLE I

Additional Variable Stars in the LS Catalogues

Star No.	Spectrum	Name or Suspected Var. No.	Star No.	Spectrum	Name or Suspected Var. No.
LS I			LS I		
+55° 2	OB(ce)	14775	+60°291	OB$^+$ce	997
+55 22	OBce	702	+60 298	OB	1009
+56 2	OBce,h	14718	+60 304	OB	1129
+56 28	OB$^-$	719	+61 16	OB$^-$	14653
+56 63	OBce	897	+61 95	OB$^-$	14748
+56°82	OB$^+$	1027	+61°125	OB	57
+57 35	OBce	727	+61 150	OB$^-$ce,h	153
+57 48	OB$^-$	761	+61 279	OB	847
+57 94	OB	918	+61 286	OB$^+$	850
+57 123	OB$^+$ce,h	1019	+62 113	OBce	177
+59°25	OBce,h var	14792	+62°123	OBce,(le),h!	190
+59 41	OB$^-$	149	+62 132	OBce,le,h	205
+59 130	OBce	801	+62 134	F2 I	208
+59 149	OB	915	+62 169	OB$^-$	LR Cas
+59 175	OB(ce)	1079	+62 232	OB$^+$ce	1048
+59°176	OBce	1080	+62°234	OBh	1145
+59 180	OB	1101	+68 17	F6 I	SU Cas
+60 63	OB$^-$(h)	14781	+69 5	OB$^-$	AL Cas
+60 204	OB$^-$	662			
+60 268	OBce	955			

TABLE I (cont.)

Star No.	Spectrum	Name or Suspected Var. No.
LS II		
+16° 4	WN(5)	11797
+24 5	OB	BN Vul
+30 17	OB^{-}	12687
+31 4	OB	923 Cyg
+35 30	OBce,le,h	12791
+36° 20	OBr	12850
+37 61	OBle	13007
+37 71	OBr	13034
+38 26	OB	12976
+38 82	OBr	13067
+39° 34	OBr	13041
+40 5	OB^{+}r	12907
+40 25	OB	13054
LS III		
+41° 26	OBr	13126
+41 27	OBr	13129
+43 18	OB^{-}	13606
+44 26	OBh	13407
+44 41	OB^{+}	13600
+45° 33	OB	13393
+45 34	OB^{-}h	13395
+45 41	OBh	13450
+45 53	OBce,h!	13564
+46 32	OB^{-}	13436
+49° 28	OB^{-}	V537 Cyg
+50 4	(OB)	V747 Cyg
+53 68	OB	14098
+54 20	OB^{-}	NV Cep
+54 39	OB	AW Lac
+58° 9	OB^{-}	13748
+58 64	OB^{+}	14337
+59 23	OB^{+}	14069
+62 19	OB	14344
+62 23	OB^{-}	14354
+62° 30	OB^{-}(h)	14371
+65 1	OB^{-}(ce)	13966

Star No.	Spectrum	Name or Suspected Var. No.
LS IV		
-11° 21	OB^{+}r	10803
-11 45	OB^{-}	11381
-11 51	F3 Ib	12766
- 9 23	OB^{+}h(r)	11252
- 6 42	OB	CT Sct
+ 0° 3	OB^{+}(h)	V603 Aql
+ 1 16	OB^{-}	12219
LS V		
+20° 3	OB^{-}	1969
+21 29	OB	2859
+22 8	OB^{-}	2805
+22 43	OB^{-}	2900
+24 14	OBh	2868
+34° 45	OBl	2053
+35 15	OBh	1971
+37 11	OBce,h!	1947
+40 36	OB	1871
+41 3	OB^{-}	1500
+46° 15	OBl	V469 Per
+47 3	OBl	RY Per
+50 9	OB	1701
+53 I 4	OB^{-}	V353 Per
+57 I 98	OBr	EO Per
+58° I 87	OB	V362 Per
+59 I 149	OB^{-}	915
LS VI		
- 8° 5	OB	3376
- 8 7	OB	3378
- 2 18	OB^{+}h	3857
- 1 12	OB	3271
+ 1 10	OB	3177
+ 4° 7	OB^{-}	3006
+ 9 17	OB^{-}	3168
+14 7	OB^{+}	2967

WILLIAM P. BIDELMAN
Warner and Swasey Observatory
Case Western Reserve University
Cleveland, Ohio 44106 U.S.A.

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ADDENDA AND CORRECTIONS TO THE NEW CATALOGUE OF SUSPECTED VARIABLE STARS

A few misstatements or errors noted in working with the extremely useful New Catalogue of Suspected Variable Stars are listed below:

NSV	Remarks
266	=V594 Cas
454	not variable; typographical error in ref. cited
799/800	same star
1759	=BB Eri
3408	type M8 (W.P.Bidelman); not BD star
4602	=NT Car
4875	not light variable; r.v. variable in ref. cited
4877	ditto
4970	ditto
5062	ditto
5100	ditto
5120	probably not LTT 4124; see Ap.J. Suppl. 39, 89
5270/5271	same star (D.J. MacConnell)
5611	not variable? probable misprint in Ap.J. 144, 496
5647	Wolf 414, not Wolf 414B
6235	probable member of ω Cen (M. N. 140, 265)
6403/6404	same star, CoD $-17^{\circ}3913$ (D. J. MacConnell)
6741	=V641 Cen
9963	=V479 Oph
10950	probably V935 Sgr
14016	probably AP Ind
14337	magnitude data in error

WILLIAM P. BIDELMAN

Warner & Swasey Observatory
Case Western Reserve University
Cleveland, Ohio 44106, U.S.A.

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PHOTOELECTRIC MINIMA TIMES OF VW CEPHEI

Photoelectric observations of the eclipsing binary VW Cephei have been carried out in September - November 1982 with the 50-cm telescope of the Bucharest Observatory.

The times of minima have been obtained with the Kwee and Van Woerden's method (1956). The following ephemeris formulae have been used:

$$\text{Min (Hel. J.D.)} = 2439348.415 + 0^{d}.278314\ E \qquad (1)$$

(Second Suppl. to the Third Edition of the GCVS, 1974)

$$\text{Min (Hel. J.D.)} = 2433898.441 + 0^{d}.27831793\ E \qquad (2)$$

(Kwee 1966).

Table I

Hel. J.D. 2440000.	$(O-C)_1$ days	$(O-C)_2$ days	s.m.e. days	Min. type	Filter
5219.3140	+0.0044	-0.1263	±0.0005	II	B
5219.3129	+0.0033	-0.1274	±0.0003	II	V
5263.2879	+0.0046	-0.1266	±0.0003	II	B
5263.2877	+0.0044	-0.1268	±0.0002	II	V
5264.2585	+0.0011	-0.1301	±0.0007	I	U
5264.2585	+0.0011	-0.1301	±0.0010	I	B
5264.2645	+0.0072	-0.1241	±0.0002	I	V
5275.2557	+0.0049	-0.1265	±0.0002	II	B
5275.2567	+0.0059	-0.1255	±0.0002	II	V
5276.2326	+0.0076	-0.1238	±0.0008	I	B

The Hel. J.D., the $(O-C)_1$ computed with formula (1), $(O-C)_2$ computed with formula (2), the square mean error, the type of minima and the filter used are given in Table I.

C. CRISTESCU, G. OPRESCU

Center for Astronomy and Space Sciences
Str. Cutitul de Argint Nr. 5.
75212 Bucharest, Romania

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THE BINARY SYSTEM V368 CASSIOPEIAE

The binary system V368 Cassiopeiae was observed at the Bucharest Observatory with a 50-cm telescope using an EMI 6256-B uncooled photomultiplier in the interval 1978-1981. The light curve has been obtained in the UBV-system using the comparison star BD+58°567.

The observations have been represented using the ephemeris

$$\text{Phase} = (\text{Hel. J.D.} - 25554.320)/4.451642$$

given in the Second Supplement to the Third Edition of the GCVS (1974). In Figure 1 the U light curve is represented from 298 individual observations. The preliminary elements have been computed using a Horak-type model while

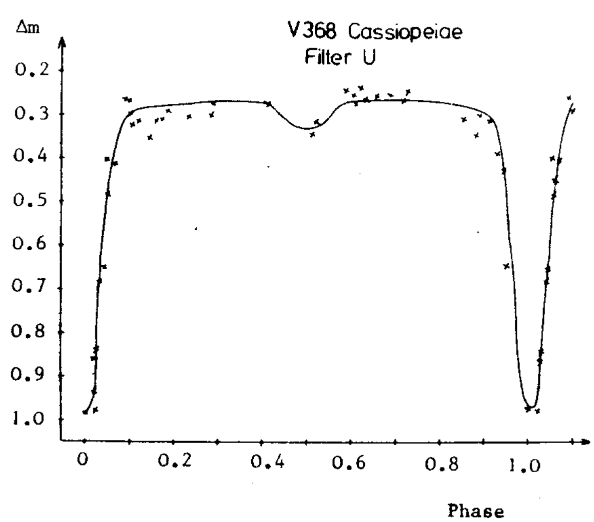

Figure 1

the improvement of the solution yielded from the WINK-model by Wood. The results are given in Table I and the theoretical light curve is represented in Figure 1 by solid line.

Table I

Fixed parameters	Auxiliary parameters	Variable parameters
$T_1 = 23800^{\circ}K$	$a_1 = 0.3271$	$r_1 = 0.3196$
$u_1 = 0.250$	$b_1 = 0.3197$	$r_2 = 0.2147$
$u_2 = 0.600$	$c_1 = 0.3120$	$i = 89\overset{\circ}{.}731$
$w_1 = 0.0$	$a_2 = 0.2204$	$T_2 = 9705^{\circ}K$
$w_2 = 0.5$	$b_2 = 0.2136$	$L_1(\text{norm}) = 0.9679$
$q = 0.47$	$c_2 = 0.2103$	$L_2(\text{norm}) = 0.0321$
	$L_1(\text{app}) = 0.2945$	
	$L_2(\text{app}) = 0.0098$	

The agreement between the theoretical light curve and observations (crosses) seems to be satisfactory. Similar solutions have been obtained for B and V filters.

C. CRISTESCU, G. OPRESCU, M.D. SURAN
Center for Astronomy and Space Sciences
str. Cutitul de Argint Nr. 5
75212 Bucharest, Romania

Reference:

Kukarkin, B.V. et al., (1974) The Second Supplement to the Third Edition of the GCVS, Moscow, Nauka

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POLARIMETRIC OBSERVATIONS OF THE RED VARIABLE RV HYDRAE

RV Hydrae (= HD 73766 = SAO 136144) is a SRc type variable star (spectrum M5 II :Keenan, 1942). Photographic magnitude is known to vary from 8.7 to 10.04 with a period of 116 days (Payne-Gaposchkin, 1954, Gaposchkin, 1956).

Linear polarization of RV Hya has been measured on 1984 March 4, 5 and 6 using the photoelectric polarimeter Sterenn on the 1 meter telescope at Pic du Midi observatory (France). Unpolarized stars were observed to check that no instrumental polarization was present, and standard polarized stars to calibrate the measurements. Three measurements through B filter and one through V filter were performed (see table below).

J.D. 2445000+	filter	p (%)	θ_{eq}
763.53	B	0.92 ± 0.08	$88^\circ \pm 2^\circ$
764.49	B	1.06 ± 0.08	$89^\circ \pm 2^\circ$
765.52	B	1.05 ± 0.10	$89^\circ \pm 2^\circ$
765.52	V	0.53 ± 0.05	$88^\circ \pm 2^\circ$

Position angle θ_{eq} is computed in the equatorial frame. B and V magnitudes cannot be determined precisely. But it seemed that the star was near light maximum.

To the knowledge of the author, no linear polarization measurement of RV Hya has been published. Since the galactic latitude of RV Hya is 19° and the stars in the neighbourhood are not strongly polarized, the polarization measured is probably intrinsic and not interstellar. Such a polarization is quite common among red variables. The decrease of polarization from 1% in B to 0.5% in V is in agreement with what is observed in polarized red variables (see for example, Shawl, 1975). Usually polarization varies with light intensity: more observations are needed.

J.F. LE BORGNE

Observatoires du Pic du Midi et de Toulouse
14 Av. E. Belin - 31400 Toulouse - France

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SPECTROPHOTOMETRY OF PECULIAR SHELL STAR HD 218393

HD 218393 is a well known shell star having several interesting spectral features. Struve (1944), Merrill (1949), Holliday (1950) and Doazan and Peton (1970) observed this star spectroscopically and noticed a series of changes in the spectrum. The radial velocity variations of the circumstellar lines suggested a period of 35 to 40 days but the amplitude was not exactly the same. Doazan and Peton (1970) interpreted the radial velocity variations as caused by an expanding envelope with variable accelerations, while after analysing all the available radial velocity data of HD 218393, Kriz and Harmanec (1975) suggested that the object may be an interacting binary with a possible orbital period of $38^{d}.873$. Later on, Polidan and Peters (1976) proved the binary nature of the star by the discovery of some lines of the secondary component in the infrared part of the spectrum. According to them, the system consists of a B3e primary and gK1 secondary. Harmanec et al. (1977) observed this star photometrically and discovered its photometric variability of $0^{m}.3$, $0^{m}.1$ and $0^{m}.1$, respectively, in U, B and V filters. They observed a gradual decline taking place during about 10 days in 1974 and more rapid variation during 1976.

We observed HD 218393 spectrophotometrically in the wavelength range $\lambda\lambda$3200-8000 Å with the Hilger and Watts scanner during two nights on 12 and 13 November 1983. The scanner was mounted at the Cassegrain focus of the 104-cm reflector of Uttar Pradesh State Observatory. In addition, the stars α Lyr and ξ^2 Cet were observed as the standard stars while the stars 2 And (A3V) and 8 Cyg (B3IV) were observed as the comparison stars. All the scans were obtained with 50 Å band pass. The observational techniques and the data reduction procedure were the same as used earlier (Goraya, 1981). The absolute monochromatic fluxes of Be star and comparison stars were extracted from the observed continuous energy distributions at about 49 wavelengths separated by 100 Å in the whole observed spectrum. The monochromatic fluxes were corrected for interstellar reddening and were normalized to λ 5500 Å. A plot of the mean monochromatic fluxes against the wavelength is shown in Figure 1.

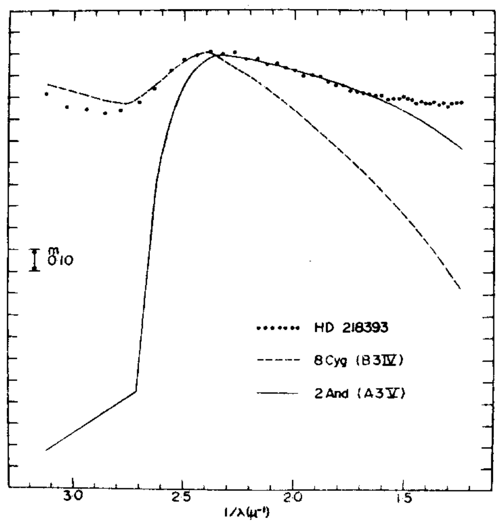

Figure 1

Observed continuous energy distribution curve of HD 218393 compared with the early type star 8 Cyg (B3IV) and the late-type star 2 And (A3V).

We compared the observed energy distributions of 2 And and 8 Cyg with Kurucz's (1979) model atmospheres. We found that the observed curves of 2 And and 8 Cyg fit well with models having T_{eff} = 8300K and 20000K, respectively over the whole spectral range. Surprisingly we noticed that the observed energy distribution curve of HD 218393 could not be fitted with any model. It is clear from Figure 1 that the observed curve of HD 218393 matches with 8 Cyg in the near ultraviolet and Balmer discontinuity region (λλ3200-4200 Å). Some part of Paschen continuum region (λλ4200-6000 Å) of HD 218393 matches well with 2 And. A near infrared excess longward of λ6000 Å was also noticed for HD 218393. From this type of peculiar continuum energy distribution we infer that the continuous spectrum of HD 218393 is a combination of the spectrum of hotter primary component (early B-type) and the spectrum of secondary cooler companion (K-type).

The observed anomalies in the continuous energy distribution of HD 218393 lead to suggest that the object is an interacting binary star, consisting of B type primary and K type secondary, in which the hotter B star is heavily obscured by a gaseous disk or ring. Outside the star, the disk itself radiates, usually as an optically thin hydrogen cloud. This continuous radiation of the disk becomes relatively stronger as we proceed towards longer wavelengths in the optical region, resulting in a near infrared excess emission.

P.S. GORAYA, MAHENDRA SINGH, U.S. CHAUBEY
Uttar Pradesh State Observatory,
Naini Tal-263129, India

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PHOTOELECTRIC OBSERVATIONS OF THE ECLIPSING VARIABLE β PERSEI

The famous eclipsing binary system Algol was observed during 26 nights, Sept.-Dec. 1983, with the new 40 cm Cassegrain telescope of Al-Battani Observatory, (Iraq, Tarmiya, Latitude 33°47'32'' N, Longitude 44° 22'28.6''E) using a photoelectric photometer equipped with an unrefrigerated 1P 21 photomultiplier tube. The observations were made in UBV filters which are approximately in the standard system. The probable errors of a single observation were estimated to be about ±0.01 in the three colours, i.e. corresponding to a measure of the observational scatter at a particular phase. The variable was observed differentially with respect to the comparison star σ Per. The star α Per was observed occasionally in order to check the comparison for any variability but no significant variations were detected between σ and α Per.

The raw data were reduced to about 450 points in each filter. Since the variable and comparison were separated by about 10°, a great care was taken in applying the differential extinction corrections. The extinction coefficients were calculated from the observed apparent magnitude and the outside atmosphere magnitude of the comparison for each night, i.e.,

$$k_u = 0.48, \qquad k_b = 0.36, \qquad k_v = 0.25$$

Figures 1 and 2 show the UBV light curves and the colour indices U-B, B-V for Algol, respectively. Minimum times were determined:

J.D. Hel. 2445614.2740,	O-C = 0.002 Min II
J.D. Hel. 2445641.5135,	O-C = 0.002 Min I
J.D. Hel. 2445654.4163,	O-C = 0.002 Min II

The phases of the present observations, Epochs and O-C's were calculated according to the light elements given by Ashbrook (1976) as:

$$\text{J.D.} = 2440953.4657 + 2^{\text{d}}.8673075\ \text{E}$$

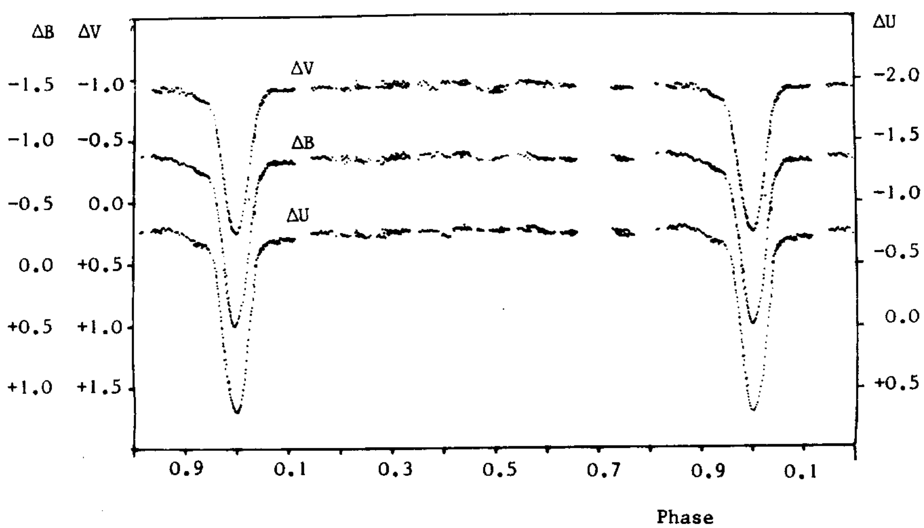

Figure 1

UBV Light Curves for Algol (β Persei)

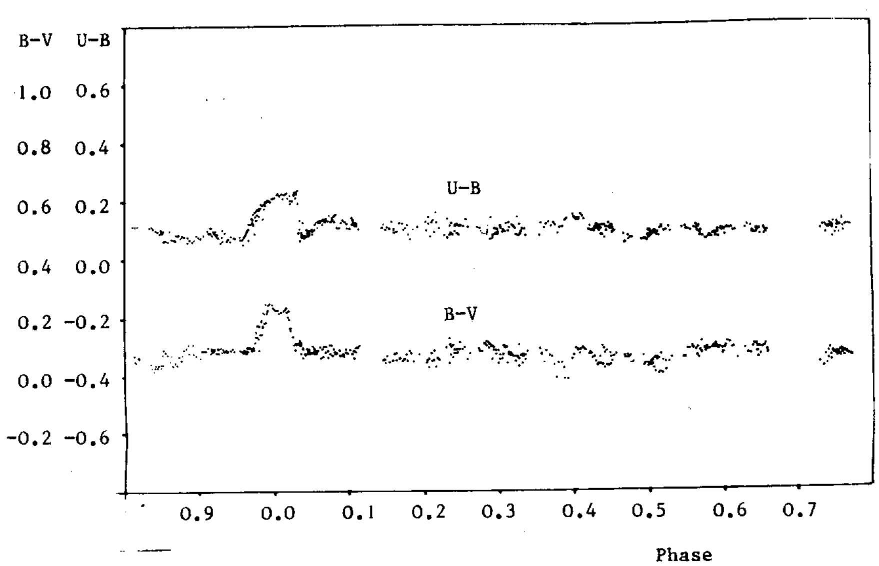

Figure 2

Colour Indices for Algol (β Persei)

The amplitude in V was (1.27 ± 0.01) magnitude. Our observations indicate the existence of asymmetry, especially in the beginning of the descending part of primary minimum. The difference was approximately $0^{m}.12$, (Figure 1). This phenomenon can be explained as a result of the presence of a gaseous stream flowing from the secondary to the primary component, starting off roughly in the vicinity of the inner Lagrangian point and falling behind the primary as that star moves round in its orbit (Walter, 1980, or Al-Naimiy and Budding, 1977).

HAMID M.K. AL-NAIMIY, ALI A.A. MUTTER, HASSAN A. FLAIH
and ALIA H.A. AL-ROUBAIE

Council for Scientific Research
Space and Astronomy Research Centre
Jadriyah, P.O. Box 255, Baghdad,
Iraq

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PHOTOMETRY OF THE BINARY Be STAR HR 2142
FROM NOVEMBER 1983 TO JANUARY 1984

We present Strömgren y, b and v photometry of the binary Be star HR 2142 (HD 41335, BD-6°1391) obtained on five nights during the interval November 1983 to January 1984. The single observation in January was made during the primary shell phase. The paucity of data is due to bad weather at the observing site. Nevertheless the observations are of interest because of the current controversy about the variability of this star.

HR 2142 (B IV-Ve, $\bar{V} = 5^{m}_{.}22$) is a Be star in an 80.86 day orbit. There are no eclipses. The system exhibits shell phases which are periodic with the binary period. The primary shell phase lasts 5½ days from phase 0.975 to 0.043, where the phase is computed according to the ephemeris:

$$T_0 = \mathrm{JD}\ 2440855.5 + 80^{d}_{.}86 \cdot E$$

in which T_0 is the time at which maximum strength of the Balmer shell lines occurs. A secondary shell episode, lasting two days, takes place shortly after. The shell lines are strongest at 0.068 phase (Peters, 1976).

The model for the system consists of a Roche lobe-filling secondary transferring material to the primary Be star. The shell lines appear when the gas streams are seen projected against the photosphere of the primary (Peters, 1981, and refs. therein).

Photoelectric photometry of this star was obtained in 1982 and 1983 by an ESO group (reported by Sterken, 1983), whose Strömgren b-band observations showed a brightness decrease of 0.13 mag occurring about 30 days before the shell phases. The brightness remained approximately constant thereafter, apparently returning to its previous level shortly after the shell episodes. At each level of brightness the light was constant to within about 0.06 mag. Recently, this result has been questioned by Harmanec et al. (1984). These authors monitored HR 2142 photoelectrically from 1979 to 1983. The last set of these observations overlaps with the ESO data. No significant decrease in light was seen at the time that the ESO observers reported the 0.13 mag decrease. All their observations are consistent with a constant stellar brightness, apart from a scatter of about 0.06 mag in the B-band. No periodic variations were detected. Neither group was able to observe HR 2142 during the primary shell phase, which is where significant light variations are expected to occur.

Our observations were made with the 61 cm reflector of National Central University, Taiwan, using Stromgren vby filters. The pulse-counting photometer is equipped with an RCA C31034 Ga As photocell refrigerated to -20°C. The comparison star was HR 2205 (= HD 42690, B2 V, V = $5^{m}_{.}05$), which is the same as that used by Harmanec et al. (1984) and is the one chosen for the International Campaign (Harmanec et al. 1980). Observations were made in the pattern *sky-comparison-variable-comparison-sky*, with each integration lasting 30s on the first two nights and 40s thereafter. Typically two such sets were obtained each night in the three filters. The data were corrected for the effects of differential atmospheric extinction, and nightly means were formed. The observations are listed in Table I, which includes the number of points forming each normal (n), and the standard deviation (σ). The observations are in the instrumental system. The data are shown in Figure 1.

By chance, a long spell of bad weather was temporarily broken on January 8, 1984, which allowed us to obtain a data point during the primary shell phase. Unfortunately, this is an isolated point, with no observations during the preceding 30 days, nor any afterwards. It is also an observation made at a relatively large zenith distance (sec z $\sim$ 3) so some caution has to be exercised in evaluating it.

From the figure it can be seen that there is no decrease in brightness indicated by the January point, which is at phase 0.015 i.e. within the primary shell phase. Over the whole observing interval the light appears to remain approximately constant, but the data are too few for a definite conclusion. We note that the comparison star

Table I
Photoelectric photometry of HR 2142

Julian Date (hel.) 2440000.0 +	Phase	Δ mag (V-C) (σ)			n
		y	b	v	
5656.23	0.37	0.196 (0.009)	0.300 (0.005)	0.340 (0.019)	12
5657.19	0.38	0.180 (0.008)	0.293 (0.010)	0.341 (0.015)	8
5673.29	0.58	0.178 (0.005)	0.283 (0.007)	0.339 (0.006)	5
5678.19	0.64	0.169 (0.010)	0.285 (0.010)	0.336 (0.017)	5
5708.28	0.015	0.160 (0.014)	0.270 (0.014)	0.340 (0.028)	4

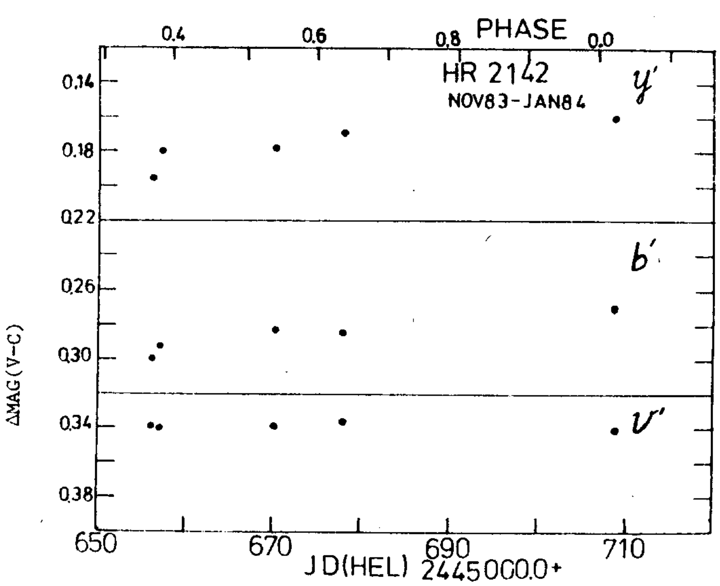

Figure 1
The ybv light curves of HR 2142 for the interval November 1983 to January 1984

is located to the east of the variable, and an overcorrection for extinction would result in this last point being too high but we estimate that, at worst, this error would be only $\sim$0.03 mag in b. We conclude that there is no evidence for the star being significantly fainter at this phase. Our observations do not cover the phases at which the ESO group observed the 0.13 mag brightness drop, but at least near phase zero there is no evidence for a decrease of this order.

We wish to acknowledge the support of the National Science Council of the Republic of China.

J. DAVID DORREN, HSIEH-HAI FU and HSIN-HENG WU
Institute of Physics and Astronomy
National Central University, Chungli, Taiwan 320.

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ECLIPSING Ap STARS

In the Catalogue des périodes observées pour des étoiles Ap, Catalano and Renson (1984) notice that three Ap stars are eclipsing binaries. Although the eclipses of HD 68826 were already studied long ago (see below), HD 34364 is referred to by most authors as the only Ap eclipsing binary (e.g. Hack, 1981, p.90), the results allowing to confirm the nature of the variations of CpD-60°981 and to establish definitely its period have been published only after the achievement of Catalano and Renson's catalogue. Here we call attention to these rare and little known objects, as the study of the changes undergone by their spectra during the eclipses may provide valuable information about the inhomogeneous distribution of the chemical elements over their surface (which would be responsible for the spectroscopic variations observed in most Ap stars, according to the oblique rotator model).

The data relevant to these eclipsing binaries are summarized hereafter in Table I.

Table I

A	B	C	D	E	F	G	H	I	J
34364	17 Aur = HR1728	AR Aur	$5^h15^m.0$	$+33^\circ43'$	6.1	B9 MnHg	4.1347	0.69	0.52
-	NGC2516-38= CpD-60°981	-	$7^h57^m.4$	$-60^\circ44'$	9.5	A2SrCrEu	3.175	0.17	0.15
68826	CoD-48°3586	AO Vel	$8^h10^m.4$	$-48^\circ36'$	9.3	B9 Si	1.5846	0.4:	0.2:

Column headings: A = HD number, B = other identifications, C = variable star name, D = α (1950.0), E = δ (1950.0), F = m_V, G = spectral type, H = period (days), I = depth of the primary minimum (mag.), J = depth of the secondary minimum (mag.)

The first one, 17 Aur = AR Aur (= HD 34364), has been known for almost a decade as a Mn-Hg star (Wolff and Wolff, 1975). Its eclipses have been studied for more than half a century (see the references quoted by Zverko et al., 1981, and by Catalano and Renson, 1984), while its orbital elements, as a spectroscopic binary, have already been computed by Wyse (1936) and by Harper

(1937). Due to the advantageously large inclination of its orbital plane, 88.4° (Johansen, 1970, table 9), a very large fraction of the surface of each component (B8V and B9.5V) is eclipsed in turn. Furthermore, as it is much brighter than the other two stars reported here, spectra may be obtained during its eclipses with a higher signal-to-noise ratio and a better time resolution. Its belonging to the Mn-Hg subgroup of Ap stars may a priori appear as less favourable, since the spectral variations of these stars, if any, are usually very small (as those of the Am stars, among which more than a dozen eclipsing binaries are known), and the distribution of the various elements over their surface is thus presumably rather homogeneous. However, results of observations obtained in October 1977 during the eclipses by Takeda et al. (1979), partly confirmed by other observations in November 1979 (Takada, 1982), raised several unanswered questions.

The second star of Table I, Cox 38 in NGC 2516, is mildly Ap, but belongs to the Sr-Cr-Eu type (Hartoog, 1976). Its eclipsing nature has been known only for a short time (North et al., 1982, North, 1984). The star is rather faint, so that a fast detector is required to get a good insight into the changes of the spectra during the eclipses, which are unfortunately very partial and last for less than four hours.

Finally, HD 68826 = AO Vel is a Si star (Bidelman and MacConnell, 1973), i.e. of a type generally displaying rather large variations, so that one can infer that there are significant surface inhomogeneities. While preparing the general catalogue of Ap and Am stars, one of the authors of this note (P.R.) noticed that this star has a variable star name, having long been known to undergo eclipses. Unfortunately, it is almost as faint as the former. That is probably the reason why it has hardly been studied (Hertzsprung, 1937, star II; Oosterhoff and van Houten, 1949) and data on its orbital motion are lacking.

During the recent meeting of the European Working Group on Ap Stars (Zurich, March 1984), five members of the group (R. Faraggiana, R. Kroll, G. Mathys, P. North and P. Renson) planned to observe the evolution of the spectra of each of these stars during eclipses.

P. RENSON

Institut d'Astrophysique
de l'Université de Liège
5, avenue de Cointe
B-4200 Ougrée (Belgium)

G. MATHYS

Institut für Astronomie
ETH-Zentrum
CH-8092 Zurich (Switzerland)

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SOME PECULIARITIES OF NINE DELTA SCUTI STARS

On the basis of observational data published by Breger (1979), we have investigated various physical characteristics of 89 Delta Scuti stars. Several variables exhibit some peculiarities; these are considered in the present note.

1. The mode of radial pulsations was estimated in two ways by using both the absolute bolometric magnitude M_{bol} and the pulsation "constant" Q (Tsvetkov, 1982). It was difficult, however, to estimate the mode of six of the variables considered.

a. By comparison of the observed absolute bolometric magnitude M_{bol} ($= M_V$ + B.C.) with a known set of absolute bolometric magnitudes $M_{bol,n}$ we estimated the mode of each star. $M_{bol,n}$ were calculated from theoretical period-effective temperature-luminosity relations for the four lowest modes by using the observed period and effective temperature(n = 0,1,2,3 corresponds to mode F, 1H, 2H, 3H, respectively, $M_{bol,0} > M_{bol,1} > M_{bol,2} > M_{bol,3}$). The difference between the two kinds of luminosities of a given star estimated in this way does not exceed 0.2-0.3 mag but for the six variables mentioned above, this difference is too large (see Table I).

b. We also estimated the modes by comparison of the observed pulsation "constant" Q with the mean values of the pulsation "constants" Q_n for the four lowest modes: 0.033, 0.025, 0.020, 0.017 days for mode F, 1H, 2H, 3H, respectively. The difference between the two kinds of pulsation "constants" for these six variables is also too large (Table I).

2. Three kinds of masses (in solar masses) are also listed in Table I: evolutionary masses $M_{e,I}$ and $M_{e,P}$, interpolated from the evolutionary tracks of Iben (1967) and Paczynski (1970), respectively, masses $M_g = g R^2/G$, computed from the stellar radii R and surface gravities g (G denotes the gravitational constant); pulsation masses M_Q, calculated by means of Faulkner's (1977) fitting formulae for a chemical composition (X,Y,Z) = (0.70, 0.28, 0.02).

Table I

Peculiar Delta Scuti variables

Star HR	HD	Name	M_{bol}	$M_{bol,0}$ or $M_{bol,3}$	Q (days)	$M_{e,I}$	$M_{e,P}$	M_g	M_Q
238	4818	V 526 Cas	2.32	1.02	0.072	-	1.70	1.56	0.35
515	10845	VY Psc	0.83	0.09	0.052	2.03	2.18	2.09	0.90
3662	79439	18 UMa	2.02	0.82	0.065	1.72	1.84	1.54	0.42
4746	108506	FT Vir	1.56	2.34	0.010	1.72	1.85	1.37	?
7020	172748	δ Sct	1.51	0.61	0.055	1.72	1.86	1.71	0.65
7859	195961	ρ Pav	2.43	1.81	0.045	-	1.64	1.28	0.72
1225	24832	DL Eri	1.29	0.82	0.045	1.81	1.96	2.00	1.09
3185	67523	ρ Pup	1.70	1.37	0.040	1.65	1.77	1.67	1.16
5017	115604	20 CVn	1.42	0.97	0.041	1.75	1.90	1.70	1.09

Note (according to Tsvetkov, 1982). For the first six stars without mode estimate: $M_{bol} - M_{bol,0} > 0,5$ and $Q > 0.045$ or (for FT Vir only) $M_{bol} - M_{bol,3} < -0.5$ and $Q < 0.012$. For the three last stars with a doubtful estimate of fundamental mode (F?): $0.3 < M_{bol} - M_{bol,0} \leq 0.5$ and $0.037 < Q \leq 0.045$.

It is evident from Table I that the pulsation masses M_Q are too small in comparison with the other two masses (the difference varies from about 2 to 5 times). One gets for FT Vir an abnormally large mass M_Q (not given in Table I). We note that for the "normal" Delta Scuti stars there is an agreement (within the limits of the accuracy of determination) between the estimates of these three kinds of masses.

Data for three variables with a doubtful estimate of fundamental mode (F?) are also listed in Table I. For these stars, the above considered peculiarities are smaller but yet considerable.

Because of the indicated peculiarities, the nine variables in Table I have been excluded from our investigations of various semiempirical relations for Delta Scuti stars.

Thus, we confirm and extend our results from an earlier note (Tsvetkov, 1979), in which the variables δ Sct and ρ Pup were considered. The former star has been discussed time and again (see, e.g., references in the cited note). As to ρ Pup, a transient Ca II K chromospheric emission at a phase of maximum outward acceleration as well as a bump in the radial velocity curve were observed in this star (Dravins et al., 1977). The variables FT Vir and ρ Pup are situated outside the instability strip (towards the lower effective temperature), the latter star has an unreliable absolute visual magnitude M_v (Breger, 1979). Five of the six variables (excepting FT Vir) without a mode estimate have a very low luminosity for their period. VY Psc and DL Eri pulsate with more than one period (Breger, 1979).

The indicated peculiarities of the variables in Table I may be due to various causes: the observational data are not accurate, the ordinary photometric calibrations are not applicable to these stars; the considered variables may belong to another type of variable stars, nonradial oscillations may be excited in them, etc.

The star FT Vir is a special case. Its very low Q value of 0.010 day may be due to nonradial pulsations in a high overtone p_k. From Tables 17.2 of Cox (1980) for linear, adiabatic, nonradial oscillations of polytropes with a polytropic index $2 \le \nu \le 4$ ($\ell = 2$), one may estimate a mode p_7 for FT Vir. It is interesting to note that Kurtz (1982) estimated a similar mode (p_6) from the value of Q = 0.011 day for the "rapidly oscillating Ap star" 21 Com (Kurtz, 1982, Musielok and Kozar, 1982, Garrido and Sânchez-Lavega, 1983). Moreover, Kurtz suggests that perhaps many B, A, F, G stars oscillate in p modes of low ℓ, high k as does the Sun.

One can note in this context that both radial and nonradial oscillations may be excited in models of Delta Scuti stars (Dziembowski, 1977). Some sort of mode coupling might account for the complicated observed behaviour of many of these objects. From the observational point of view, some real Delta Scuti variables (in particular, 1 Mon = HR 2107 = HD 40535) perform probably nonradial pulsations (see Section III and Table III in Breger, 1979).

New detailed observations and theoretical investigations are required in order to understand the peculiarities of the stars considered in this note.

TS.G. TSVETKOV
Department of Astronomy
University of Sofia
Anton Ivanov Street 5
1126 Sofia, Bulgaria

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CORRECTION TO I.B.V.S. No. 2489

"In the discussion of FT Ori I should have noted that J. Tomkin was, in fact, the first to observe line doubling in that system. I am collaborating with him in the analysis of our spectroscopic material."

C.H. LACY

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THE ENIGMATIC ECLIPSING BINARY W CRUCIS: AN APPEAL TO SOUTHERN OBSERVERS

W Crucis (HD 105998, α = 12h 09.6m, δ = -58° 30', epoch 1950.0) is one of the most puzzling eclipsing binaries in the sky. It is sufficiently bright to be easily accessible to observations (its V magnitude varies approximately between 8 and 9.5 mag), but its rather long period, 198.53 days, makes it less attractive to observers. Yet there are some most exciting rewards for those who take a look at it.

The next primary eclipse is predicted for 1984 July 11.88, if we accept the ephemeris T = 2440731.6 + 198.53 E, essentially based on O'Connell (1936). The difficulty with such a long-period system is that a small error or a small change in the period may shift the mid-eclipse by several days either way. The eclipse is broad and its duration hard to define, since the light variation, at least in the B spectral region, is continuous. From O'Connell's photographic light curve, it appears that the steep branches of the primary eclipse last some 30 days each, and the photographic magnitude variation is about 0.8 mag within this time interval.

An accurate location of the mid-eclipse is very desirable. According to O'Connell, there exists a brief period of totality, but its duration and, in fact, mere existence are strongly model-dependent, and it is almost certain that O'Connell did not (and could not, in 1936) find the correct photometric elements for this enigmatic system.

The mystery begins with the continuous light variation, which is usually labelled the "Beta Lyrae-type light curve"--a most unfortunate designation, but most likely quite fitting here. Why should such a large system contain stars so tidally distorted and apparently nearly in contact? The primary star (the one eclipsed at the primary eclipse) has a spectrum of a G1 Iab supergiant, and its radial velocity curve appears to be rather undistorted according to Woolf (1962) (who, incidentally, was the first one to call attention to the many puzzles discussed here). This radial velocity curve yields a large mass function, $f(m) = 5.8\ m_{\odot}$, implying that the secondary star must be fairly massive --in fact, more massive than the visible star! For example, if we assume $8\ m_{\odot}$ for the primary supergiant, then the secondary should have almost $15\ m_{\odot}$. Yet its spectral lines are absent, according to Woolf, even at primary mid-eclipse. Recently, Paul B. Etzel observed the system outside eclipse with the HCO spectral scanner at the 1.5m telescope of the CTIO, and his scan can be satisfactorily interpreted in terms of a single G1-type supergiant, reddened by an amount corresponding to $E(B-V) = 0.30$ mag. Yet the solutions of the light curve by O'Connell and later by Kopal (1941) postulate a secondary star somewhat cooler than the primary (about G8) but roughly twice as large, so that the flux from both stars should be comparable even in the blue!

The system displays Balmer emission lines between $H\alpha$ and $H\delta$ at all phases, which is something quite unusual for such a late spectral type, and this makes W Crucis rather similar to RX Cassiopeiae. Woolf also noted hydrogen shell lines indicating substantial gas streams inside the system, or mass outflow from it.

Many of these aspects are strongly reminiscent of Beta Lyrae. In Beta Lyrae, we also do not see any absorption lines of the secondary star, although its continous radiation is present. In the past, formal light curve solutions resulted in a later spectral type for the secondary (F5) than for the primary (B8), but today we know that the secondary is a disk which in the far ultraviolet has a higher color temperature than the primary. I have observed

W Crucis with the IUE, but I found no similar disk continuum in the ultraviolet. There is a weak continuum present, but it is probably due to optically thin radiation of a fairly hot circumstellar hydrogen cloud. Fairly strong emission lines of a rather hot circumstellar plasma are also present, mainly Si IV, Si III and Si II, C II and a weaker C IV, Al II and Al III, and Fe III. Observations near the primary eclipse indicate that the line emitting region is probably not much affected by the eclipse, but a cooler component of the circumstellar plasma is. In short, W Crucis is a W Serpentis system (Plavec 1980), but it is more similar to RX Cassiopeiae than to Beta Lyrae.

There is hope that more can be learned from the ultraviolet spectrum if observations are made in and near the predicted totality. For that, new and more accurate eclipse timing is necessary. But, since probably neither star is visible in the ultraviolet, the key to further substantial progress, as in the case of RX Cas, seems to lie in optical and infrared spectroscopy and photometry. I hope that the awareness of this fact will encourage the southern observers to look at W Crucis. A good timing of the forthcoming primary eclipse would be an important first step.

MIREK J. PLAVEC

Department of Astronomy

University of California

Los Angeles, CA 90024

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UBVRI PHOTOMETRY OF SOUTHERN ACTIVE CHROMOSPHERE STARS*

During the past few years the active chromosphere stars received much attention because of the variety of extraordinary phenomena exhibited by them. Since the majority of these interesting objects lies north of -40° declination, the discovery of the new bright southern active stars is an important task. Based on medium dispersion spectra, the selection of the potential southern active chromosphere candidates was done by several authors: Bidelman and MacConnell (1973), Weiler and Stencel (1979), Hearnshaw (1979), Bopp and Hearnshaw (1983). In all these papers the most important criterion for chromospheric activity was the abnormally strong emission in absorption lines of Ca II H and K and/or H α. As the majority of the known chromospheric active stars shows intrinsic small amplitude light variations (up to 0.3 mag) we have undertaken a photometric program for searching for new active stars. Based on the above mentioned candidate lists we have chosen six stars for which, as we know, photometry has not yet been done (except for two observations of HD 155555 - Eggen, 1978). We have selected stars showing extremally strong H and K Ca II and/or H α - emission, which suggest good chances for finding optical variability (in analogy to the well known northern RS CVn systems like HR 1099 or UX Ari). In this paper we present very preliminary results of UBVRI photometry of chosen stars.

The observations were carried out at the European Southern Observatory at La Silla, during 12 consecutive nights from 13 April 1984 on. The ESO 50 cm telescope equipped with single beam photometer housing the RCA 31034 gallium-arsenide photomultiplier in conjunction with a standard UBVRI set of filters as described by Bessel (1979) was used. The observations were made differentially; absolute photometry of the comparison stars was obtained during 9 nights under the best weather conditions. During these nights at least 30 standards were observed to tie in the comparison stars to the

*Based on observations collected at the European Southern Observatory, La Silla, Chile

standard UBVRI system. The constancy of the main comparison was checked several times per night during the first few nights and at least two times later, when it was realized that they are stable. The standard errors for a single observation are $0^{\mathrm{m}}.015$, $0^{\mathrm{m}}.008$, $0^{\mathrm{m}}.007$, $0^{\mathrm{m}}.008$, $0^{\mathrm{m}}.005$ for the UBVRI colour bands, respectively.

Table I

Summary of the UBVRI photometry of the southern active chromosphere stars

Object	Sp*	Main Comparison	Secondary Comparison	Variability	V Ampl. (mag)	Remarks
HD 86005	K2IIIp	HD 86034	HD 85849	NO	-	1
HD 102077	K0/IVp	HD 102076	HD 102202	FOUND	0.08	
HD 119285	K1Vp	HD 119164	HD 119076	?	<0.03	2
HD 127535	K1IV/Ve	HD 128227	HD 128618	FOUND	0.24	
HD 139084	K0V	HD 139070	HD 139002	FOUND	0.11	
HD 155555	K1Vp	HD 156427	HD 154775	FOUND	0.08	

*According to Houk and Cowley (1975) and Houk (1978).

Remarks:

1. Mean colours: $V=7^{\mathrm{m}}.230$ $B-V=1^{\mathrm{m}}.307$ $U-B=1^{\mathrm{m}}.026$ $V-R=0^{\mathrm{m}}.711$ $V-I=1^{\mathrm{m}}.347$
   m.e. .005 .007 .011 .003 .005
2. Variability possible, but with the period longer than duration of our run (12^{d}).
   Mean colours: $V=7^{\mathrm{m}}.856$ $B-V=1^{\mathrm{m}}.092$ $U-B=0^{\mathrm{m}}.831$ $V-R=0^{\mathrm{m}}.636$ $V-I=1^{\mathrm{m}}.241$
   m.e. .017 .007 .015 .005 .010

Evidence for photometric variability was found for 4 stars from our sample. In Table I we list the summary of our observations, i.e. HD number of objects and comparisons. For the found variability we also give the V amplitudes and for the remaining stars all colours. The more detailed analysis and light curves will be published in forthcoming papers.

A. UDALSKI* and E.H. GEYER

Observatorium Hoher List der Universitäts-Sternwarte Bonn
D-5568 Daun, F.R.Germany

*On leave from the Warsaw University Observatory, Poland

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OBSERVATIONS OF AT Cnc IN THE SEASON 1983/84

The star which is probably of cataclysmic type was inspected on 24 blue-sensitive plates (ORWO-ZU21 + GG13 + BG12) obtained in the B system with the Schmidt camera 50/70/172 cm of Sonneberg Observatory covering the time interval between 1983 December 3 and 1984 March 23; the sequence of comparison stars given in I.B.V.S. No. 2363 was used. These observations are listed in Table I.

Table I

J.D. 244...	m_B	J.D. 244...	m_B
5672.522	$13^{m}.00$	5680.515	$15^{m}.83$
5672.549	12.79	5683.633	12.79
5672.576	12.79	5684.627	13.34
5672.603	12.66	5750.323	12.66
5672.660	12.66	5752.420	14.57
5673.511	13.21	5761.319	13.07
5673.533	13.34	5763.359	15.25
5673.558	13.34	5779.347	15.98
5674.530	14.57	5780.344	15.11
5674.553	14.16	5781.339	12.52
5676.547	15.98	5782.335	12.66
5679.507	>15.0	5783.331	12.59

The light curve of the star shows variations over the whole amplitude between $m_B = 12^{m}.5$ and $m_B = 16^{m}.0$. A remarkable increase of brightness with $\Delta m_B = -3^{m}.46$ within $1^{d}.992$ was stated between 1984 March 19 and March 21. On the other hand on the series of plates from 1983 December 3 and December 4 only small variations can be seen.

W. GÖTZ

Akademie der Wissenschaften
der DDR, Zentralinstitut für
Astrophysik, Sternwarte Sonneberg

CORRIGENDA (to I.B.V.S. No. 2477)

On p.1. The observed time of Min. II is J.D. 2444679.6663.
(The J.D. of this minimum is correctly stated in Table I.)

On p.2. Table I. The O-C value given for the last two minima is +0.0097 and not +0.0079. (These residuals are correctly plotted in Fig.1.)

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FO Vir: A NEWLY-DISCOVERED ECLIPSING BINARY

FO Vir (1950 coords: $13^h27^m.2$, $+1^\circ21'$) is a bright (V~6.6) A-type star that bears the designation of RR? in the GCVS. Jackisch (1972) found it to be variable by about 0.3 mag in V with a period of order 0.5 to 0.7 day, a figure disputed by Poretti (1977), who found a period of 0.2859 day from visual estimates. Eggen (1983), however, from four-colour observations spanning quarter of a day showed the period must exceed 0.5 day.

During April and May of 1983 we obtained four-colour photometry of FO Vir with our 0.6-m reflector at this observatory, as well as thirty-eight 12 A/mm spectrograms with our 1.9-m telescope for radial velocity purposes. Our intention was to find a more accurate period and to clarify the nature of the star, the suggestion of RR Lyrae seeming doubtful at best.

Since we could find no reference to a modern spectral classification of the star, Dr Robert Garrison kindly obtained a number of plates with his classification spectrograph on our 0.6-m telescope in Chile and reports a firm classification of A7 V. We thank him for this.

A power-spectrum analysis of our data yielded a period of 0.7755 day, and this enabled us to phase our observations to those of Eggen obtained up to five years earlier. With these the period is improved to 0.775567 $\pm$ 0.000004 day.

Figure 1 shows our preliminary light and velocity curves for FO Vir. The radial velocities are offset by an arbitrary zeropoint due to the manner in which they were reduced; a more complete discussion will correct this. Meanwhile, a first estimate of the systemic velocity is -44 km/sec, but this is uncertain because of the blending effects described below. The open circles represent Eggen's photometric observations, we are most indebted to him for communicating the details of these.

The nature of the star seems clear from Figure 1: it is a partially eclipsing binary with ellipsoidal components. But a rough analysis of the velocity curve yields a mass function of only 2×10^{-3} $M_\odot$, which is much lower than one would expect. For $i \sim 90^\circ$ and a primary star mass of about

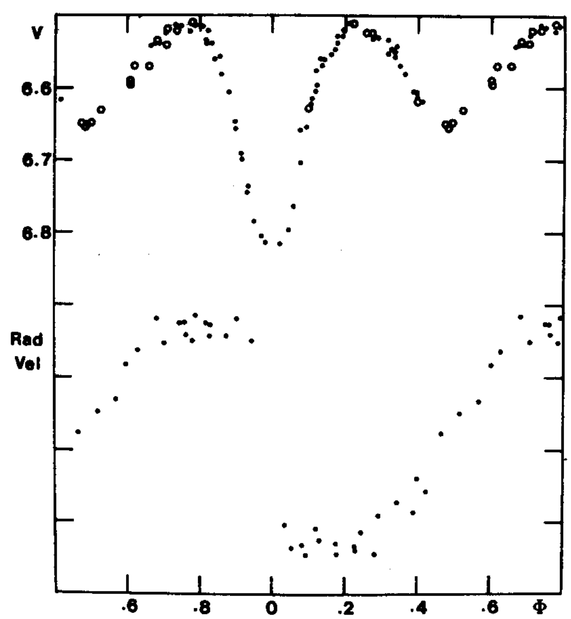

Figure 1

The light- and velocity-curve of FO Vir. Open circles in the light-curves represent earlier observations by Eggen. Tic marks on the velocity-curve axis are 10 km/sec apart.

2.0 $M_{\odot}$, this mass function implies a secondary star mass of only about 0.2 $M_{\odot}$, whereas the depth of secondary eclipse and the colour indices suggest the secondary is more likely an F dwarf. Since the mass function scales as the cube of the velocity curve amplitude, we suggest that the conflict arises through blending of the primary star's spectral lines with those of the secondary, which would act to reduce the velocity extrema.

We are making further observations to improve the light and velocity curves, as well as adding RI photometry and Reticon spectroscopy at Hα and beyond in the hope of unravelling the secondary star problem.

Our best current estimate for the ephemeris of primary minimum is

$$\mathrm{HJD} = \underset{\pm 5}{2445441.7110} + \underset{\pm 4}{0.775567}\,E$$

It is a pleasure to acknowledge discussions with Dr.s C.T. Bolton and S. Mochnacki regarding the nature of FO Vir, and we thank Mr Ron Lyons for assistance with the radial velocity measurements. This work was supported in part through an operating grant from the Natural Sciences and Engineering Research Council of Canada to one of us (JDF).

F.H. SCHMIDT
J.D. FERNIE
David Dunlap Observatory
Box 360
Richmond Hill, Ontario
Canada L4C 4Y6

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COMMENTS ON THE P-L-C RELATION OF THE CLASSICAL CEPHEIDS

The problem of P-L-C relation for classical Cepheids:

$$M_{<V>} = a \log P + b<B-V>_{o} + c \qquad (1)$$

is discussed nowadays for the reason of various numerical values proposed for the colour term coefficient b and because of many critical remarks concerning the methods of calculation of this quantity, see Clube and Dave (1983). Here we present the arguments in favour of a large value of the colour term coefficient for galactic and LMC Cepheids in accordance with Brodie and Madore's (1980) results.

1. The paper by Fernie (1984) contains the list of Cepheid radii obtained by Wesselink method. The $<B-V>_{o}$ for these stars have been obtained from the $<B-V>$ values taken from a catalogue by Schaltenbrand and Tammann (1971) and reddenings from Dean et al. (1978) and Pel (1978). On the basis of these data we got for 20 most reliable radii and log P<1 the following P-R-C relation:

$$\log R = \underset{\pm 0.113}{1.029} \log P - \underset{\pm 0.181}{0.572} <B-V>_{o} + \underset{\pm 0.077}{1.259} \qquad (2)$$

$$\text{s.d.} = 0.042$$

The small value of the colour term coefficient −0.572 justified the application in this case of the standard least squares method, which due to the narrow range of $<B-V>_{o}$ and its correlation with log P leads to a systematic lowering of greater values of coefficients. In order to pass from log R to the absolute magnitudes, $M_{<V>}$, we use the formula:

$$M_{<V>} = -5 \log R + S_{V}, \qquad (3)$$

where S_{V} is the surface brightness:

$$S_{V} = 42.312 - 10 \log T_{e} - \text{B.C.} \qquad (4)$$

According to van Genderen (1983), for Cepheids

$$B.C. = 0.430 - 0.603 \langle B-V\rangle_o \quad (5)$$

and $$\log T_e = 3.870 - 0.175 \langle B-V\rangle_o \quad (6)$$

So we got

$$S_V = 3.182 + 2.353 \langle B-V\rangle_o \quad (7)$$

and the P-L-C relation:

$$M_{\langle V\rangle} = -5.295 \log P + 5.213 \langle B-V\rangle_o - 3.115 \quad (8)$$

From this example we see that the small values for b are not acceptable because of significant dependence of S_V on $\langle B-V\rangle_o$. Therefore b should be greater than 2.353 and in this case amounts to 5.213.

2. As the next group of stars we consider the long period Cepheids in LMC. The following numerical data have been taken from the paper by van Genderen (1983): log P, V_{Jo} which we assume to be equal to $M_{\langle V\rangle}$ + Mod, and $(B-V)_{Je}$ instead of $\langle B-V\rangle_o$. In this case we use the following procedure, avoiding the least squares method:

Eq. (1) means that the Cepheids are placed on the plane in the three dimensional space: log P-$M_{\langle V\rangle}$ - $\langle B-V\rangle_o$. We divide the group of the investigated stars into two halves with shorter and longer periods and calculate for both groups the mean values: $\log P_1$, $M_{\langle V\rangle 1}$, $\langle B-V\rangle_{o1}$ and $\log P_2$, $M_{\langle V\rangle 2}$, $\langle B-V\rangle_{o2}$. We assume that the points with the coordinates so obtained are placed also on the plane defined by eq. (1). The projections of these points on the log P-$M_{\langle V\rangle}$ plane have the coordinates $\log P_1$, $M_{\langle V\rangle 1}$ and $\log P_2$, $M_{\langle V\rangle 2}$ and they determine the P-L relation as the straight line:

$$M_{\langle V\rangle} = g \log P + h \quad (9)$$

The individual deviations of stars from this line:

$$\Delta M_{\langle V\rangle} = M_{\langle V\rangle} - g \log P - h \quad (10)$$

are due to the arrangement of stars on the P-L-C plane and should not be treated only as errors. On the contrary, their existence is a proof of reality of the plane defined by eq. (1).

Similarly we got the P-C relation as a straight line

$$\langle B-V\rangle_o = d \log P + e \quad (11)$$

on the log P-$\langle B-V\rangle_o$ plane passing through the points $\log P_1$, $\langle B-V\rangle_{01}$ and $\log P_2$, $\langle B-V\rangle_{02}$. So it is possible to calculate the similar deviations for individual stars:

$$\Delta\langle B-V\rangle_o = \langle B-V\rangle_o - d \log P - e \tag{12}$$

From the geometry of this problem it follows that the deviations $\Delta M_{\langle V\rangle}$ and $\Delta\langle B-V\rangle_o$ and the quantities occurring in eqs. (1), (9), and (11) are related as follows:

$$\Delta M_{\langle V\rangle} = b\Delta\langle B-V\rangle_o, \tag{13}$$

$$a = g - b\, d, \qquad c = h - be \tag{14}$$

This method applied to 19 long-period Cepheids in LMC according to van Genderen's paper (1983) led to the following results:

$$V_{Jo} = M_{\langle V\rangle} + \mathrm{Mod} = -2.516 \log P + 16.413,$$

$$(B-V)_{Je} = \langle B-V\rangle_o = 0.472 \log P + 0.078$$

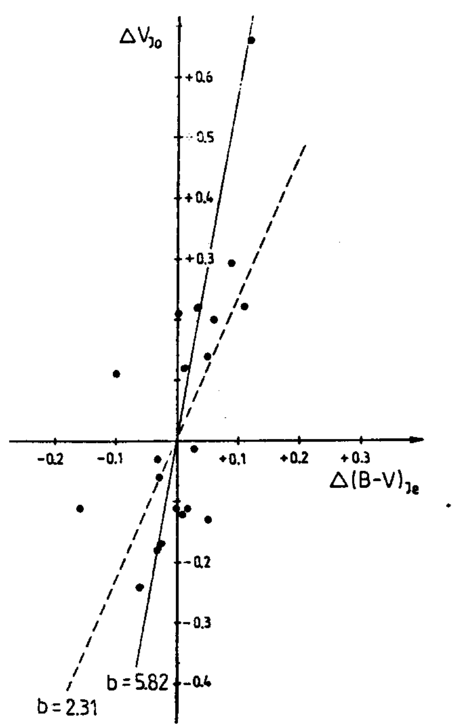

Figure 1

Determination of the coefficient b for the LMC Cepheids

The deviations $\Delta V_{Jo} = \Delta M_{<V>}$ and $\Delta(B-V)_{Je} = \Delta<B-V>_o$ are plotted in Figure 1. Using again the mean values of these quantities for positive and negative $\Delta M_{<V>}$ we got from eq. (13)

$$b = 5.82$$

and from eqs. (14): a = −5.26 and c + Mod = 15.96. The same numerical data, treated by standard least squares method, led to the values:

$$a = -3.474, \quad b = 2.307, \quad c + \mathrm{Mod} = 16.040.$$

As it was stated above in this case the least squares method gives significantly lower value for the coefficient b. But, as is shown in Figure 1, b = 2.307 does not suit with the observational points.

3. Finally the $M_{<V>}$ and $<B-V>_o$ values for 51 galactic Cepheids with $<B-V>_o < 0.85$ have been taken from the author's paper, (Opolski, 1982) and subjected to the same method as LMC stars. The results are as follows:

$$M_{<V>} = -2.635 \log P - 1.971,$$

$$<B-V>_o = 0.424 \log P + 0.304,$$

$$a = -5.310, \qquad b = 6.31, \qquad c = -3.457$$

In order to get in this problem the results without systematic errors introduced by the least squares method it is enough to change the form of the P-L-C relation to:

$$<B-V>_o = x \log P + y\, M_{<V>} + z \tag{15}$$

In this case the small numerical values of the coefficients x and y and the greater range of the $M_{<V>}$ variability allow to get proper results using the least squares method. In this way for stars in the LMC taken again from van Genderen's paper (1983) we got:

$$(B-V)_{Je} = \underset{\pm 0.130}{0.884} \log P + \underset{\pm 0.051}{0.173}\, V_{Jo} - \underset{\pm 0.839}{2.726}$$

$$\mathrm{s.d.} = 0.048$$

From this we have:

$$V_{Jo} = -5.106 \log P + 5.774(B-V)_{Je} + 15.739,$$

whereas the application of the same method directly to the eq. (1) gives:

$$V_{Jo} = -\underset{\pm 0.357}{3.474} \log P + \underset{\pm 0.686}{2.307}(B-V)_{Je} + \underset{\pm 0.257}{16.040}$$

$$\mathrm{s.d.} = 0.176$$

But this solution has a systematic error. The differences between the observed and calculated V_{Jo} are correlated with these quantities. The negative differences are predominating in the range of smaller V_{Jo} while the positive ones are connected mostly with larger V_{Jo}. Therefore they do not have the character of accidental errors.

Similarly for galactic Cepheids (Opolski, 1982) we got:

$$\langle B-V\rangle_o = \underset{\pm 0.095}{0.982} \log P + \underset{\pm 0.035}{0.191} M_{\langle V\rangle} + \underset{\pm 0.076}{0.646}$$

$$\text{s.d.} = 0.054$$

or $$M_{\langle V\rangle} = -5.141 \log P + 5.238\langle B-V\rangle_o - 3.384$$

For this case eq. (1) gives directly:

$$M_{\langle V\rangle} = \underset{\pm 0.206}{-3.548} \log P + \underset{\pm 0.367}{1.998}\langle B-V\rangle_o - \underset{\pm 0.131}{2.540},$$

$$\text{s.d.} = 0.176,$$

with the similar systematic error as in the foregoing example. Also the result obtained by Martin et al. (1979) for 26 stars in the LMC achieved by the maximum likelihood fit: $a = -3.80$, $b = 2.70$, $c + \text{Mod} = 16.41$, is encumbered with the systematic errors.

It is worth to notice that nine SMC Cepheids, (van Genderen, 1983), give more consistent results:

$$(B-V)_{Je} = \underset{\pm 0.151}{1.349} \log P + \underset{\pm 0.063}{0.338} V_{Jo} - \underset{\pm 1.032}{5.789}$$

$$\text{s.d.} = 0.038$$

or $$V_{Jo} = -3.988 \log P + 2.957(B-V)_{Je} + 17.119$$

The relation obtained directly from eq. (1) for these stars is the following:

$$V_{Jo} = \underset{\pm 0.283}{-3.702} \log P + \underset{\pm 0.454}{2.454}(B-V)_{Je} + \underset{\pm 0.220}{17.009}$$

$$\text{s.d.} = 0.101$$

In this case the smaller value of the coefficient b causes that the lowering from 2.957 to 2.454 is not so significant as in the other examples.

A. OPOLSKI and T. CIURLA
Wroclaw University Observatory
51-622 Wroclaw, Poland

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1983-84 OBSERVATIONS OF THE BRIGHT ECLIPSING BINARY 1 Per

After the observations carried out in 1981-82 (Poretti, 1982), in 1983-84 1 Per ≡ V 436 Per has been followed more intensively at Merate Observatory. In this occasion I used the Marcon 50 cm telescope equipped with a Lallemand photomultiplier and a standard V filter and I adopted the same comparison stars, HR 540 and 4 Per. New measures were obtained during the minima and at maximum light. I notice that it is not easy to ensure a satisfactory coverage of the light curve around the minima because the period is very close to 26 sidereal days.

Instrumental ΔV differences were converted into standard ΔV differences by means of the V and B-V values given by Hoffleit (1982) for a dozen of standard stars measured in the course of the program. ΔV's were transformed into V magnitudes assuming V = 6.45 for the comparison star HR 540. Results are described below; phases are referred to the ephemeris (North et al., 1981)

$$\text{Min I} = \text{JD } 2443562.853 + 25.9359 \times E$$

MAXIMUM LIGHT - The 12 normal points (on the whole 118 V measures) are listed in Table I. The suspected variation (Kurtz, 1977 and Poretti, 1982) does not seem to be present. The mean magnitude is 5.553 (standard deviation 0.005 mag.).

PRIMARY MINIMUM - In two occasions (JD 2445715 and 2445741) the first contact of the primary (or short) minimum was detected, with a drop of 0.21 mag. in 0.13 d. The first contact takes place at 0.9925 phase.

On these two nights 126 V measures were performed.

SECONDARY MINIMUM - The observations cover the central phase of the eclipse: the variation is very slow, but the eclipse does not seem total.

The minimum magnitude is 5.74, with an amplitude of 0.19 mag.: the minimum is slightly asymmetrical. Tentatively, two timings of minima are proposed: 2445648.444 ± 0.003 and 2445674.386 ± 0.002. Their phases are, respectively, 0.4133 ± 0.0001 and 0.4135 ± 0.0001.

On these two nights 184 V measures were performed.

Table I

Mean magnitudes of 1 Per at maximum light. σ is the standard error.

Mean J.D.	V	σ
2 445 621.37	5.556	0.003
625.38	5.547	0.006
627.35	5.557	0.002
.47	5.554	0.002
634.35	5.554	0.002
.46	5.559	0.002
635.43	5.558	0.002
641.37	5.556	0.004
647.42	5.540	0.003
677.36	5.548	0.004
.38	5.552	0.004
704.24	5.553	0.003

Table II

Mean magnitudes of 4 Per. σ is the standard error.

Mean J.D.	V	σ
2 445 621.38	5.009	0.005
625.38	5.012	0.006
627.35	5.020	0.002
.47	5.024	0.002
634.35	5.026	0.002
.46	5.025	0.003
635.43	5.018	0.002
641.38	5.012	0.003
647.42	4.990	0.002
648.39	4.995	0.002
.52	4.994	0.002
674.39	5.010	0.002
677.36	5.009	0.004
.38	5.008	0.003
704.24	5.013	0.004
715.36	5.016	0.003
741.30	5.022	0.003

The 17 normal points (on the whole 191 V measures) of 4 Per are listed in Table II they show a scatter 2 times greater than 1 Per ones. As a matter of fact, the mean magnitude is 5.012 and the standard deviation is 0.011 mag. A slight variability of 4 Per is suggested: the magnitudes quoted by Blanco et al. (1968) seem to confirm it. 4 Per is known as a spectroscopic binary (Hoffleit, 1982) and its radial velocity is variable (Abt et al., 1972).

E. PORETTI
Osservatorio Astronomico
22055 MERATE (CO)
Italy

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A NEW LIGHT CURVE OF CG Cyg

The unusual eclipsing binary CG Cyg has a distortion wave, which seems to be advancing through the light curve at an increasing rate. Because significant variations in the light curve occur over a period of months (Zeilik 1982), a new light curve was obtained by combining data from four of five consecutive nights.

These observations were made from the Climenhaga Observatory of the University of Victoria on 17-18, 18-19, 20-21, and 21-22 August 1982. A 50 cm reflector and photometric system closely matching the V and B filters of the Johnson system was used. Unfortunately due to equipment problems the sky brightness in the V band was not adequately subtracted, rendering the V data useful only for colour transformations. The observations of the variable star were bracketed by observations of the comparison star BD+34°4216, whose constant brightness was checked at least nightly with observations of BD+34°4213. The difference in B magnitude was 1.57+/-.02 indicating that the comparison star has remained constant since 1965 (Milone et al 1979). Mean extinction and transformation coefficients were used to correct the differential magnitudes to the Johnson system.

The differential B magnitudes are plotted in the figure against heliocentric phase calculated from the ephemeris of Milone and Zeibarth (1974). The phases of minimum light were $0^{P}.0174$+/-.0011 and $0^{P}.5168$+/-.0019 as found from all the data points within $0^{P}.03$ of the minimum using a computer program based on the method of Kwee and Van

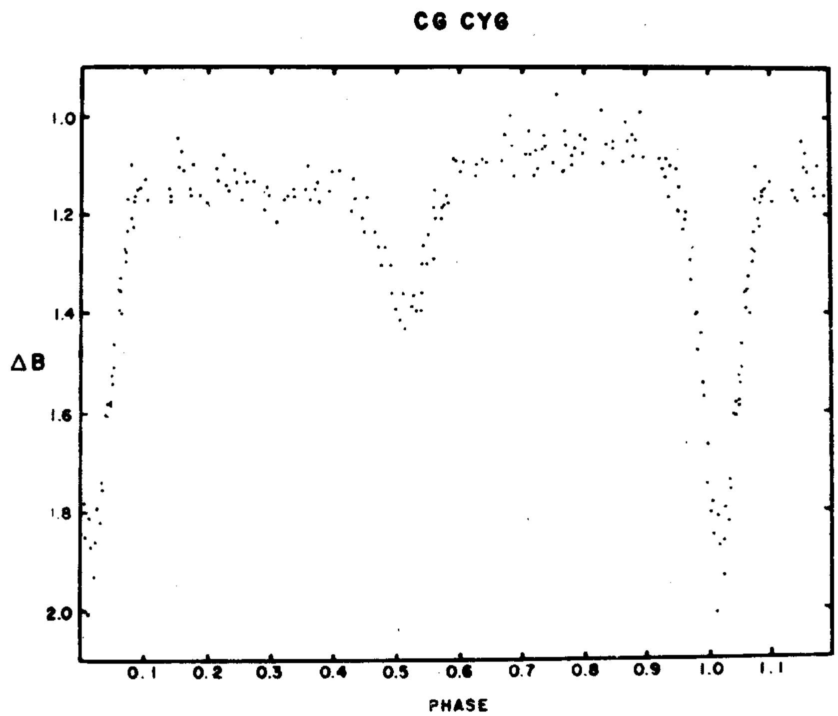

Figure 1

Worden (1956). A truncated five-term Fourier series was fit to the intensity data excluding the points within +/-$0^{p}.08$ of the observed minima. The constant term A0 is 0.3600+/-.0016 which indicates that CG Cyg is dimmer now than in 1977 and 1982. The cosine terms normalized by A0 are A1=+0.0113+/-.0061 and A2=-0.0128+/-.0067 and the normalized sine terms are B1=-0.0407+/-.0040 and B2=+0.0022+/-.0044. Following the definitions of Milone et al. (1979), the phase of the distortion wave is calculated to be 286+/-8 degrees and the amplitude is 0.0422+/-.0041.

In comparison with the past behaviour of this system, as reported by Milone et al. (1979), Zeilik et al. (1982), and Jassur (1978), the light curve seems most similar to that of 1965; so similar that the corresponding coefficients of the Fourier series of the two years are nearly within the errors of one another. Since the system experienced a change of period between 1965 and 1967, further observations may be rewarding.

The value of this light curve lies in the fact that it is unlikely that significant variations occurred during the five nights of observations. Phases of overlap, 0.05 to 0.08 and 0.54 to 0.57, were examined for significant differences and none were found. The amplitude and timescale of short term variations might be determined by comparing this light curve with others observed at nearly the same epoch. To assist other observers in making this comparison, the data have been deposited in the I.A.U. Archives of Unpublished Observations of Variable Stars, File No. 135 (Breger 1981).

R.M. ROBB
Physics Department
University of Victoria
Victoria, BC Canada V8W 2Y2

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COORDINATED SS CYGNI OBSERVATIONS

Coordinated Voyager far-UV (500 - 1700 Å) and IUE (1200 - 3200 Å) observations of the cataclysmic variable SS Cygni during two outbursts are planned for this summer. Analysis of AAVSO data on SS Cygni obtained since 1980 suggests the following dates for the beginning of the outburst: July 1 ± 5, 1984 and August 25 ± 5, 1984. In visual light SS Cyg brightness increases from $V \sim 11.8$ to $V \sim 8.5$ during the first 24 hours of an outburst then declines back to $V \sim 11.8$ over the next 7 to 17 days. We encourage observations in other spectral regions during these outbursts.

R.S. POLIDAN and J.B. HOLBERG
Lunar and Planetary Laboratory
University of Arizona
3625 E. Ajo Way
Tucson, Arizona 85713
(602) 621-4301

A.V. HOLM
Computer Science Corporation
Systems Sciences Division
Space Telescope Institute
Johns Hopkins University
Baltimore, Maryland 21218

J.A. MATTEI
American Association of
Variable Star Observers
187 Concord Avenue
Cambridge, Massachusetts 02138

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ON THREE CEPHEIDS IN M 33

Hubble (1926) suggested that variables Nos. 14, 15, 21, 32 and 45 were of Cepheid type but he did not find any periods. Recently Sharov and Kholopov (1983) determined the periods of four of these stars using Hubble's observations.

From eight plates of M 33 obtained by the 2 m RC telescope of the Bulgarian Academy of Sciences we evaluated B magnitudes of four stars (Table I).

Table I

Magnitudes of Variable Stars in B system

J.D. 2440000	14	15	32	45
4528.55	20.5	21.1	21.8	20.4
5283.34	21.0	21.1	20.95	20.2
5295.44	20.9	-	21.8	-
5296.48	20.94	21.6	21.8	20.7
5297.45	20.7	22.0	21.6	20.9
5348.38	20.7	22.0	21.65	19.85
5622.40	21.3	-	20.64	-
5624.39	20.95	-	20.95	20.9

We used the new magnitude scale of Sandage (1983). The new periods and light curve parameters are given in Table II.

Table II

Light-curve Parameters of Variable Stars

Star	B^{max}	B^{min}	<B>	$\langle B\rangle_{PL}$	Period	Epoch of max J.D. 2420000
14	20.8	21.9	21.4	20.2	46.315	4382.2
15	21.1	21.9	21.7	20.1	50.546	4108.2
21	20.1	20.7	20.5	20.0	67.22	-
32	20.5	22.1	21.5	21.2	19.99246	4148.093
45	19.9	21.0	20.5	19.9	78.88985	4405.364

The mean light curves of variables Nos. 32 and 45 show rapid brightening and slower fading (Figure 1). The $\langle B\rangle_{PL}$ magnitudes obtained through the period-luminosity relation for Cepheids and the distance modulus $m - M = 25.35$ (Sandage, 1983) are near the observed <B> magnitudes (Table II). The values

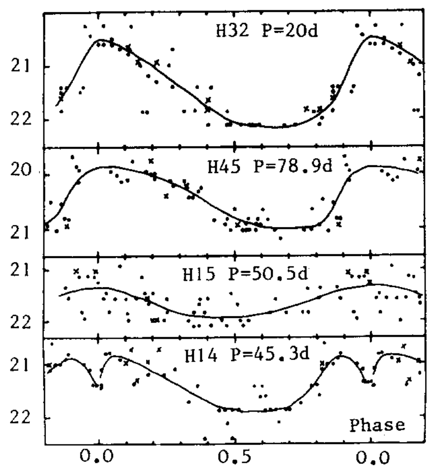

Figure 1

Light curves of variable stars. Hubble's observations are given by dots and our observations are denoted by crosses.

of the periods, amplitudes, <B> magnitudes and asymmetry of the light curves of variables Nos. 32 and 45 are typical for the Cepheids.

The variable No. 21 is near the nucleus of M 33. Hence the strong background does not permit reliable photometry. The sinusoidal light curve and the small amplitude of No. 21 obtained by Hubble's observations are similar to the s-Cepheid variables. Its <B> magnitude does not contradict to the Cepheid type luminosity.

The variables Nos. 14 and 15 are not Cepheids. The variable No. 15 has a period of $50^{d}.546$ which well represents our and Hubble's observations. Our data, however, do not confirm the period of variable No. 14 obtained by Hubble's observations. Probably this star has an unstable light curve or period. The observational data are insufficient for the determination of the type of variability but the mean light curve reminds of an RV Tau variable.

G.R. IVANOV and I.R. CHAKUROV

Department of Astronomy
University of Sofia

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THE UBV PHOTOMETRY FOR A NEW RR-TYPE VARIABLE IN Leo

A new RR-type variable in Leo, discovered by Huruhata (1983), was observed on February, March and May using UBV photometer attached to the 91 cm reflector at McDonald Observatory. The results from about 420 observations show that the period is $0^d.6738459$ instead of $0^d.402132$ given by Huruhata. The derived elements are as follows:

$$\text{Max} = \text{J.D. (H)}2445741.159(\pm 0^d.002) + 0^d.6738495(\pm 0^d.0000100).$$

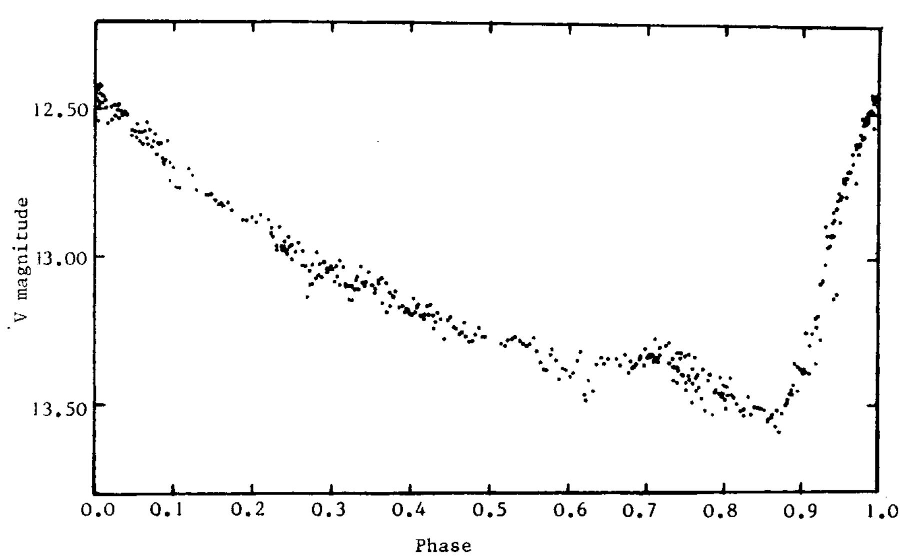

Figure 1

The light curve of V magnitude

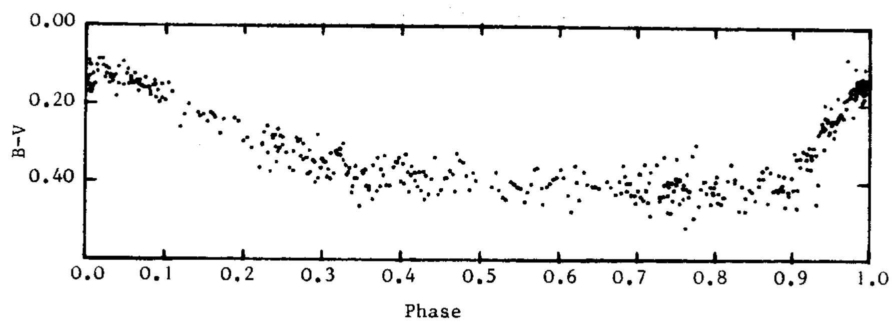

Figure 2

The variation of (B-V)

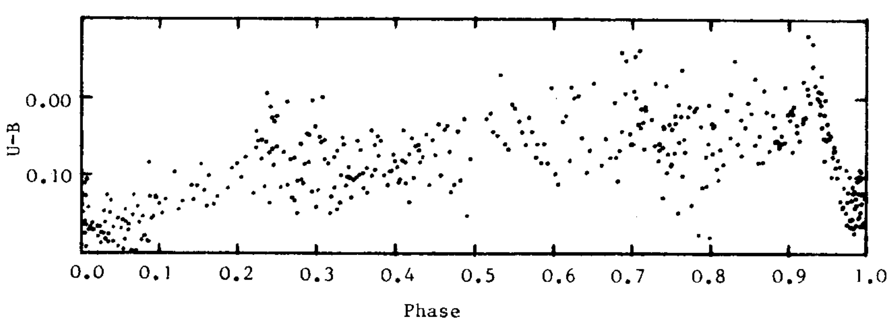

Figure 3

The variation of (U-B)

The magnitude and the colour indexes at maximum are: Vmax = $12\overset{m}{.}44$, (B-V)max = $0\overset{m}{.}10$, (U-B)max = $-0\overset{m}{.}03$. The amplitudes are: $\Delta V = 1\overset{m}{.}10$, $\Delta(B-V) = 0\overset{m}{.}34$, $\Delta(U-B) = 0\overset{m}{.}21$. The skewness of light curve, $\varepsilon = 0.14$. These characters show it is an RRa-type variable. The light curve is shown in Figure 1.

TAN HUISONG

McDonald Observatory
(A visiting scholar from Yunnan Observatory, China)

Reference:

Masaaki Huruhata, 1983, I.B.V.S. No. 2402

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HIGH DISPERSION OBSERVATIONS OF ε Aur FROM SEPT. 1982 TO MARCH 1983

Between September 1982 and March 1983 I obtained high dispersion spectra of ε Aur in selected regions using the Palomar 200-inch coude spectrograph and the Dominion Astrophysical Observatory 48-coude spectrograph. All spectra were taken with the 90-mm ITT image tube and IIa-D emulsion. Since further observations during this eclipse are not currently planned, the raw data will be presented here for others who may find them useful.

In Table I we list our radial velocities for the sodium D lines, KI lines,

Table I

Radial Velocity (km s^{-1})

Date (UT)	Disp. (A/mm)	metals	Hα (abs)	Hα (em)	NaI	KI	OI (λ7772)
3.53 Sept. 1982	6.7	+3.5±1.1	+11.3±1.0	+72	+12.8	+21.8±1.5*	+14.3
15.41 Oct. 1982	4.8				(+19.1±1.4)† (+ 6.7∓0.8)		
18.60 Oct. 1982	4.8					+22.4±0.5^Δ	
19.17 Mar. 1983	4.8	+1.5	+25.4^∇		+15.5^□		
21.14 Mar. 1983	4.8				+13.9	+ 9.9±1.5**	

* partially resolved component at +8±2 km s^{-1} is present

† two nearly equal components are clearly present but poorly resolved

Δ partially resolved component at + 4 km s^{-1} is present

∇ the deepest point in the line is at +36.6 km s^{-1} and an uncertain absorption feature may be present at -4.6 km s^{-1}. Weak emission further to the violet may be present

□ the deepest point of the D2 line is at +5.3 km s^{-1}

** a little fuzz is visible on the positive side of the KI lines

Hα, and a few other features. While most of the sodium and potassium features are surely circumstellar there is certainly an interstellar component present. In the direction of ε Aur interstellar gas is seen mostly with radial velocities between +5 and +10 km s^{-1}. The sodium D lines and potassium lines show incipient resolution which may involve the interstellar components.

The equivalent widths of the sodium and potassium lines are given in Table II. For potassium, blending with atmospheric O_2 makes the line at $\lambda 7664$

Table II

Equivalent Widths (in Å)

Date	D1	D2	KI(λ7699)
3.53/9/1982	0.77	0.82	0.36
15.41/10/1982	0.95	1.03	-
18.60/10/1982	-	-	0.40
21.14/3/1983	1.24	1.33	0.50

unmeasurable on the dates of these observations. The increase in equivalent widths already noted by Pathasarathy and Lambert is evident.

Blending and partial resolution of the circumstellar and interstellar features may account for much of the velocity structure which is only partially discernable at the available resolution.

This research was conducted by the author as a guest investigator at the Palomar Observatory, Calif. Inst. of Technology and the Dominion Astrophysical Observatory, Herzberg Institute for Astrophysics, National Research Council, Canada.

GEORGE WALLERSTEIN

University of Washington
Seattle, Washington, 98195
U.S.A.

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IRVBU OBSERVATIONS OF W URSAE MAJORIS

Observations of W Ursae Majoris, on March 5-6, 1984, with the Kitt Peak Automated Filter Photometer, on the no. 2 0.9 meter telescope, resulted in 15925 IRVBU observations in a single observing session. The time of midprimary minimum was determined by finding the midpoints of chords connecting equal values of the light level. The lower part of the light curve was symmetric in all spectral bands. It will ultimately be possible to determine an improved time of minimum with the aid of light synthesis modelling. The heliocentric midprimary time was JD 2445765.7385. The O-C residual from the ephemeris of Hamzaoğlu et al. (I.B.V.S. No. 2102) is -0.0025^{d}. Total phase was covered by approximately 90 observations in each spectral band. To within observational error, primary minimum is of constant brightness, in contrast to secondary minimum.

There was a detectable O'Connell Effect, in the sense that the maximum following primary minimum (Max I) was higher than the preceding one. The magnitude difference of the two maxima, as a function of spectral band, was as follows:

Spectral band	Max. II - Max. I
I	.019
R	.013
V	.010
B	.021
U	.023

Secondary minimum was asymmetric in the sense that egress phase light levels were below ingress phase levels, for equal displacements from midsecondary minimum, adopted as 1/2 period from midprimary. Annular phase of secondary minimum was not at a constant light level, but was 0.03 magnitudes brighter at second contact than third.

A detailed description of the light curves will appear in a separate publication.

ALBERT P. LINNELL*

Dept. of Physics and Astronomy
Michigan State Univ., E. Lansing, Mich.

*Visiting Astronomer, Kitt Peak National Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation.

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VARIABILITY OF HD 207739

(BAV Mitteilung Nr. 35)

Parsons et al. (1983) analyzed IUE spectra of HD 207739 (BD $+43^{\circ}4060$) and found a strange composite structure (F8II + B:) with some resemblance to shell and pre-main sequence B stars. As they pointed out, however, it more closely matched the spectra of the eclipsing systems VV Cep and SX Cas. The authors suggested HD 207739 to be an interacting binary, from radial velocity data they expected a period of less than a month.

HD 207739 was observed with a "Schnitzer"-photometer attached to a 25 cm Schmidt-Cassegrain telescope and using filters for B and V. As comparison served HD 208220 ($V = 9^m.49$, $B-V = +0^m.04$), as check star HD 7754. For the latter the following magnitudes were derived: $V = 7^m.06 \pm 0^m.016$ and $B = 8^m.242 \pm 0^m.015$ (SE). Because of the large zenith distances of the observations between JD 2445720 and 840 the check star was used as comparison in view of its much smaller angular distance to HD 207739.

The figure shows the results of the measurements. HD 207739 exhibited small variations between $8^m.59$ and $8^m.39$ in V and $9^m.22$ and $9^m.03$ in B whereas HD 207754

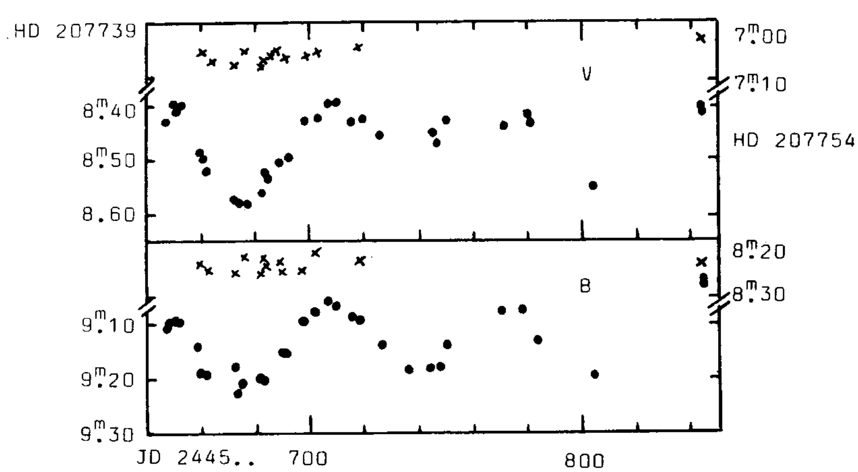

Figure 1

The light curve of HD 207739 (•) in comparison with that of HD 207754 (x) did not show significant light changes. The light curve of HD 207739 is wave like with smooth maxima and minima. The amplitude varies in V but not in B, periodicity seems possible but cannot be definitely shown by the present observations. If a period exists it should be around 65 days or in view of the different amplitudes in B and V the double of this value, thus much longer than expected by Parsons et al. (1983). The only UBV-magnitudes available in the literature (Parsons and Montemayor, 1982) were obtained on 1980 Aug.29 and 30 and Sep. 1. The authors found no significant variability, the mean values ($V = 8\overset{m}{.}59$ and $B-V = +0\overset{m}{.}66$) are almost exactly those of the minimum around JD 2445675 in the above figure. Assuming that 9 epochs have elapsed a period of $132\overset{d}{.}4$ can be calculated. However, the star needs further observations to ensure periodicity of its light variations.

The author is grateful to Mirek J. Plavec for calling attention to HD 207739.

M. FERNANDES

BAV, Munsterdamm 90
1000 Berlin 41, Germany

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TWELVE ARCHER'S VARIABLES ARE NONVARIABLES

Twelve of the 24 variables in Leo, announced by Archer (1959), were observed in February and March using UBV photometer attached to the 91 cm reflector at McDonald Observatory and V colour photometer attached to the 35 cm reflector at Yunnan Observatory. At least 20 observations were made successively for each star and covered more than the half of the period given by Archer. No variations larger than the experimental deviations were detected for Archer's number 3, 4, 7, 13, 14, 16, 17, 18, 19, 21, 22, 23. We arrived at the conclusion that these stars are not variables. All data will be published in Chinese.

TAN HUISONG

McDonald Observatory, the University of Texas
(A visiting scholar from Yunnan Observatory)

ZHANG ZHOUSHENG and ZHANG YUNLIN

Yunnan Observatory, China

Reference:

Archer, S., 1959, J.B.A.A., 69, 157

Emendation

Table III and the legend of Figure 1 in I.B.V.S. No. 2501 is not legible on most of the copies because of bad printing. For the sake of completeness we repeat Table III and the figure caption here:

Table III

Peak-to-peak amplitudes of HD 172256 variations

	V	b-y	m_1	c_1
August 1981	0.103	0.023	0.026	0.069
June 1983	0.073	0.042	0.073	0.042
July 1983	0.126	0.050	0.058	0.059
June-July 1983	0.126	0.054	0.073	0.059

Legend of the figure:

Correlation between b-y and m_1 for HD 172256 in observations carried out in August 1981, June 1983 and July 1983.

Editors

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PHOTOMETRY OF CAPELLA

At the suggestion of Dr. D. Hall we decided to measure Capella (=α Aur = BS 1708) for possible variability. We present here a small sample of photometric measurements, made differentially in the standard manner (Hall and Genet, 1982) with respect to 9 Aur (= BS 1637). For α Aur, B-V = +0.80, for 9 Aur, V = 5.00, B-V = +0.34 (see Table 9 of Johnson et al., 1966). The 1980 data were reduced with a standardization coefficient ε = -0.072. These data were reduced from ammeter readings. Observations were also made on four other nights in 1980, but the differential magnitudes showed a range greater than 0.050 mag, indicating non-uniform sky conditions or problems with the equipment. The 1981 data were made with a different photomultiplier tube (for which ε = -0.047), and were reduced from trip chart tracings. In all cases an atmospheric extinction coefficient of k_v = 0.5 mag/air mass was used. The differential extinction corrections in all cases amounted to less than 0.02 mag. The observations were made with a 6-inch f/6 reflector in San Jose, California, a standard V filter, and an uncooled RCA 931A tube operated at -1000 V.

Data in Table I includes date, Universal Time, geocentric Julian Date,

Table I

Photometry of α Aur vs. 9 Aur

Date	UT	Julian Date (2440000 +)	$\Delta\bar{V}$	n
7/8 Feb 1980	0511	4277.7161	-4.998 $\pm$.008	4
9/10 Mar 1980	0446	4308.6986	-4.999 $\pm$.010	3
12/13 Mar 1980	0420	4311.6803	-5.034 $\pm$.006	3
21/22 Mar 1980	0359	4320.6662	-5.020 $\pm$.005	3
4/5 Jan 1981	0423	4609.6824	-5.004 $\pm$.006	3
21/22 Feb 1981	0410	4657.6738	-5.039 $\pm$.008	3
28/29 Mar 1981	0422	4692.6822	-5.009 $\pm$.011	2

nightly means, and number of measurements.

The average of all 21 differential measurements is ΔV = -5.014 $\pm$0.004 (standard deviation of the mean). There is no statistically significant difference between the 1980 and the 1981 data.

This small data set indicates that Capella exhibits no variability greater than ± 0.02 mag in V. Given the standardized V magnitude of 9 Aur, Capella has $V = -0.01$. This is brighter than the value given by Johnson et al., ($V = +0.08$). Some of this discrepancy can be attributed to uncertainties in the calibration of gain settings.

K. KRISCIUNAS
UKIRT
900 Leilani St.
Hilo, HI 96720
U.S.A.

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HD 167971 - AN Of-TYPE VARIABLE*

HD 167971 (spectral type O8Ibf) is among the most luminous stars (M_{bol} = -10.6) known in our Galaxy. Due to its membership in the young cluster NGC 6604 and its apparent brightness, HD 167971 was subject of several investigations leading to very well known stellar parameters (see Leitherer and Wolf, 1984).

We observed HD 167971 with the ESO 50-cm photometric telescope in the Bessell-UBVRI-system and in the Stroemgren ubvy-system on several occasions in 1983/84. The result of our photometry is given in Table I. Obviously, HD 167971 performed variations in all observed passbands, which by far exceed the photometric uncertainty (typically $0\overset{m}{.}02$). Note that the colours of HD 167971 remained constant within the limits of uncertainty.

Table I

Photometry of HD 167971

JD	V	B-V	U-B	V-R	V-I	y	b-y	m_1	c_1
2445555.589	7.40	0.78	-0.35	0.52	1.08	-	-	-	-
5560.583	7.38	0.78	-0.41	0.52	1.07	-	-	-	-
5561.583	7.65	0.79	-0.39	0.52	1.07	-	-	-	-
5586.613	-	-	-	-	-	7.60	0.58	0.00	-0.24
5596.600	-	-	-	-	-	7.58	0.54	-0.02	-0.22
5600.573	-	-	-	-	-	7.37	0.59	-0.02	-0.22
5602.567	-	-	-	-	-	7.37	0.59	-0.02	-0.23

In Figure 1 we illustrate the variations of HD 167971 in the V and y passbands over the period of observations. Since the photometric systems for V and y are nearly identical for spectral type O8, V and y-magnitudes can be immediately compared without any transformation. Figure 1 implies that HD 167971 is variable by $\sim 0\overset{m}{.}30$. Further observations will be necessary to find or exclude a periodicity of these variations.

*Based on observations collected at the European Southern Observatory, La Silla, Chile

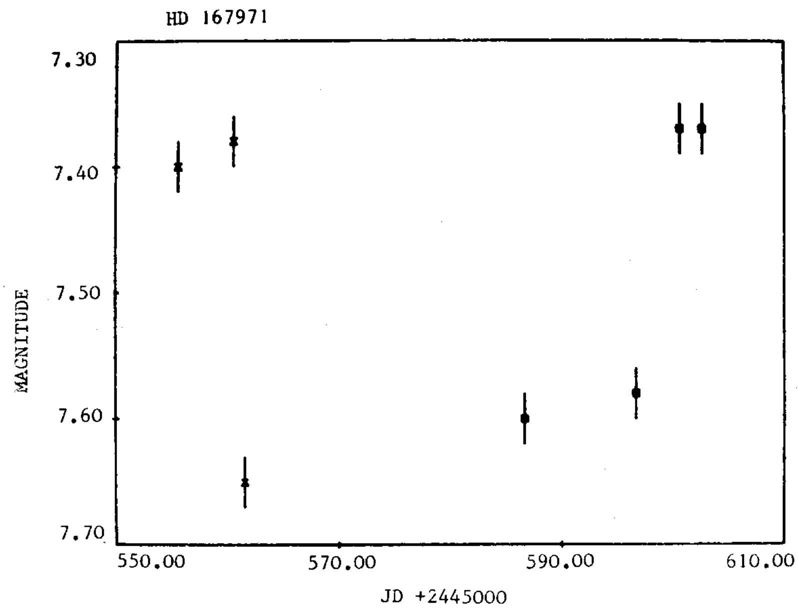

Figure 1
V measurements (x) and y measurements (□) of HD 167971 between JD 2445550 and JD 2445610

In order to check the possibility of contamination of our photometry by nearby field stars, we examined a POSS IR survey plate (see Figure 2). Although the field around HD 167971 (star no. 1 in Figure 2) is crowded, no star with magnitude comparable to V = 7.50 is within the diaphragm of the photometry (15 arcsec). Stars nos. 2 and 3 are of magnitude V = 12.85 and V = 12.95, respectively (Moffat and Vogt, 1975). Further stars discernibly close to the disk of HD 167971 are even fainter (I > 15 mag), so that the result cannot be affected by these objects.

We should like to mention that no indication of variability has yet been published for HD 167971. Several older measurements found in the literature give an average magnitude of V = 7.50 $\pm$ 0.05 during the last twenty years.

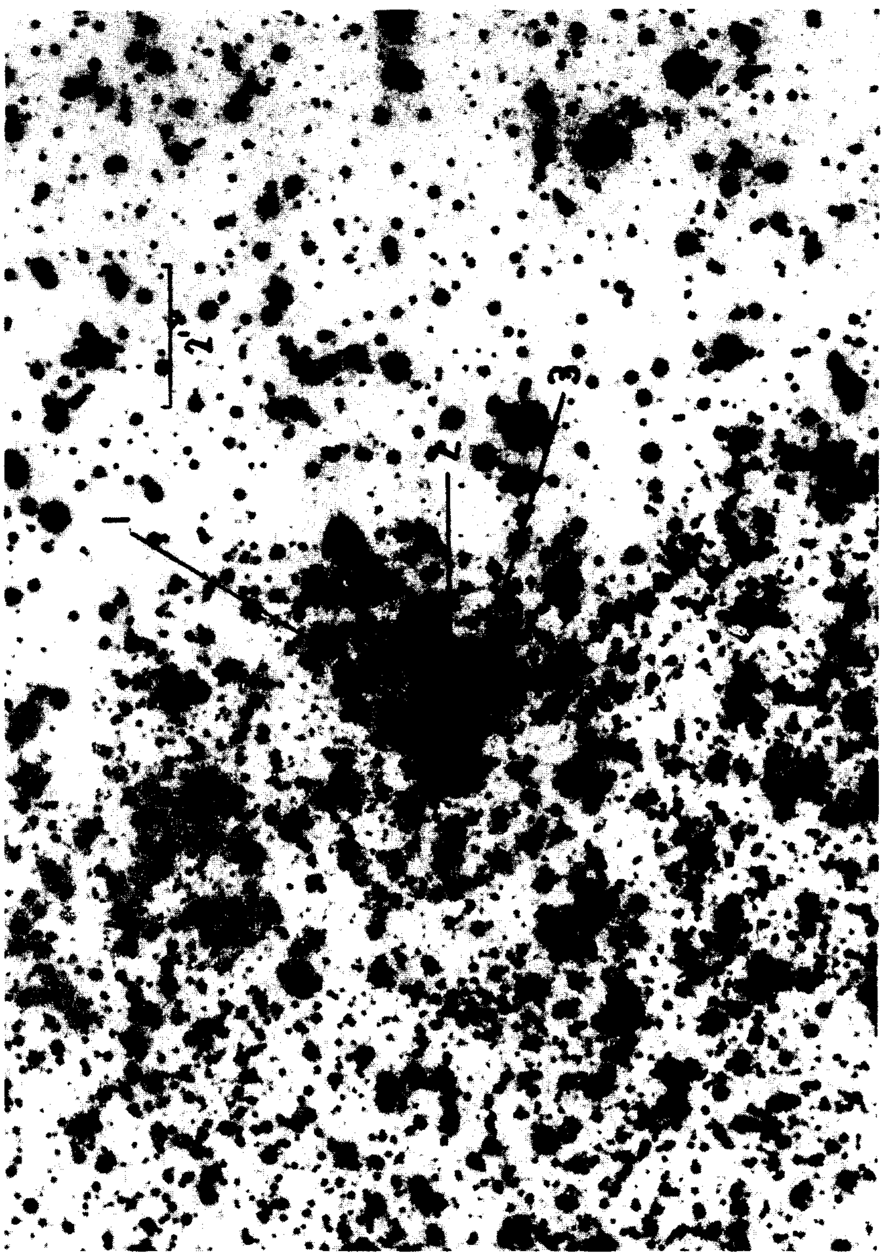

Figure 2
Enlargement of POSS IR plate No. 23981 showing the field around HD 167971 (no. 1). North is up and east to the left.

Acknowledgements:
We are grateful to C. Sterken's "Long-Term Photometry of Variables" group who provided the Stroemgren photometry of HD 167971. We are also indebted to H. Jahreiß (ARI) for providing the bibliography of HD 167971 from the CDS (Strasbourg). This work was sponsored by the Deutsche Forschungsgemeinschaft (SFB 132).

C. LEITHERER, O. STAHL, F.-J. ZICKGRAF, G. KLARE, B. WOLF
Landessternwarte Königstuhl, D-6900 Heidelberg 1, Federal Republic of Germany

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THE BEHAVIOUR OF KR AURIGAE IN THE SEASON 1983/84

In linking to the sequence of comparison stars given by M. Popova (1965) the star was measured on 29 blue-sensitive plates (ORWO-ZU21 + GG13 + BG12) from 27 nights obtained with the 50/70/172 cm Schmidt camera of Sonneberg Observatory. The observations which are given in Table I are covering the time interval between 1983 September 5 and 1984 April 24. The light curve

Table I

J.D. 244...	m_B	J.D. 244...	m_B
5583.572	$13^m.40$	5679.415	$13^m.33$
5585.572	13.78	5680.443	13.30
5612.521	13.77	5683.595	13.35
5612.551	13.82	5750.296	13.57
5621.519	13.92	5761.297	13.52
5621.549	13.76	5763.338	13.78
5623.519	13.88	5779.326	13.98
5641.455	13.54	5780.324	13.85
5650.472	13.58	5781.317	13.76
5651.504	13.36	5782.314	13.59
5671.417	13.52	5783.310	13.51
5672.415	13.60	5810.337	13.53
5673.383	13.46	5812.342	13.93
5674.394	13.56	5815.347	14.14
5676.403	13.62		

in B shows the star in its bright light superimposed by temporal light fluctuations. The lowest brightness ($m_B = 14^m.14$) connected with a decrease of $\Delta m_B = 0^m.61$ within $5^d.010$ was stated at the end of the series.

W. GÖTZ

Akademie der Wissenschaften
der DDR, Zentralinstitut für
Astrophysik, Sternwarte Sonneberg

Reference:

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INFRARED OBSERVATIONS OF THE BINARY STARS W UMa AND VW Cep

The binary stars W UMa and VW Cep are well known contact systems. A large number of observations of the first system in different bands allows this star to be used for the examination of any hypotheses. So UV-observations by Eaton et al., (1980) permitted to conclude on the equality of the temperatures of both components in W UMa. VW Cep is characterized by a marked photometric activity, i.e. with considerable changes of the light curve.

Some IR light curves of W UMa type systems have been obtained recently. But only 44i Boo (Bergeat et al., 1981) has high-quality IR light curves, comparable to optical ones. Our observations of W UMa and VW Cep at λ = 1.62 μm have been made with a PbS photometer at the Cassegrain focus of the 1.25 m

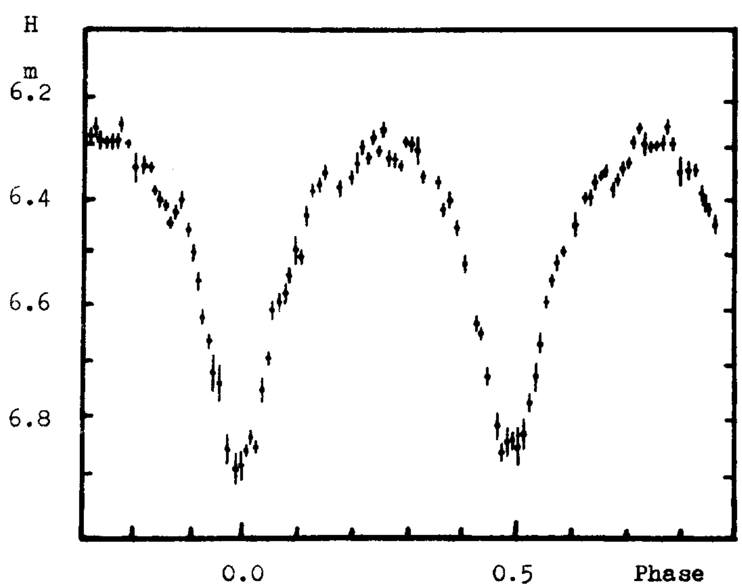

Figure 1

reflector of Crimean Station of Sternberg Astronomical Institute.

W UMa More than 600 observations of this system were obtained between January and April, 1982. The mean light curve is given in Figure 1. HD 84335 served as a comparison star and IR-values of BS 3775 were used as a standard. IR-magnitudes of the variables and the comparison stars are given in Table I.

Table I

Star \ Band		J	H	K
W UMa,	max	$6^{m}.39$	$6^{m}.29$	$6^{m}.20$
	min 1	-	6.87	6.71
	min 2	-	6.83	-
HD 84335		-	0.62	0.34
VW Cep,	max	-	5.42	5.20
	min 1	-	5.67	5.45
	min 2	-	5.66	5.49
HD 196502		-	5.25	-

Their precision as well as that of the mean light curves is $\pm 0^{m}.01 \div 0^{m}.02$.

During the period of observation W UMa was in active phase. It is followed from the optical observations by Hamzaoglu et al., (1982 a, 1982 b) namely the primary minimum was deeper than the secondary one in January but depths of minima were almost equal in April. The distortions of H-curve also point out the activity. They have the amplitude up to $0^{m}.05$. These distortions are undoubtedly caused by the existence of circumstellar matter in the system in the epoch of the observations. The light depressions of H-curve in phases 0.15-0.25 and 0.67-0.72 are provided with the blueing of (B-V) colour by $0^{m}.01 \div 0^{m}.02$.

VW Cep The observations of this binary have been made in H- and K-bands in 1981. HD 196502 served as a comparison star and IR-magnitudes of BS 7685 were used as a standard. However, the sensitivity of the detector is small at $\lambda = 2.2$ μm and therefore a reliable curve could not be obtained (Figure 2). The mean H-curve is given in this figure too. The lesser number of the observations (275) does not allow to obtain as a detailed light curve as W UMa has. The considerable asymmetry of minima is, however, noteworthy.

IR-data of the above binaries conform to spectral types F6-F8 III and G5 III for W UMa and VW Cep, correspondingly (Straizys, Sviderskiene, 1972). Thus the variables have an IR-excess.

The decrease of the light change amplitude with increasing λ which has been discovered for a series of W UMa systems by Jameson and Akinci (1979) is $0^{m}.14$ for W UMa and $0^{m}.16$ for VW Cep according to our investigations (last value is corrected for the third component discovered by Heinz (1975)). The

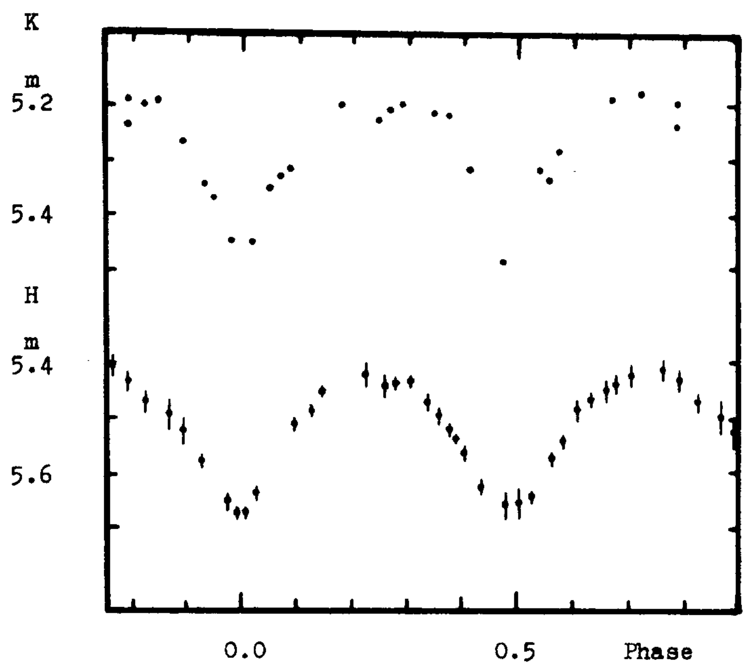

Figure 2

close value $(A_V - A_K) = 0\overset{m}{.}20$ was obtained from the observations of Lunel et. al., (1982) for VW Cep. So, the decrease of the amplitude in IR-range in comparison with optical observations by $0\overset{m}{.}15 - 0\overset{m}{.}20$ is the characteristic feature of W UMa systems. Fourier analysis of the noneclipsed parts of optical light curves, (Kwee, 1966) and of our IR-curve of VW Cep shows that $A_2 \cos 2\theta$ term is responsible for the change in the amplitude. A_2-value is −0.14 in B-band and −0.06 at $\lambda = 1.62$ μm.

The next conclusions can be drawn from our observations. The eclipsing binaries W UMa and VW Cep have an IR-excess. The depressions of IR light curve of W UMa point out the possible presence of circumstellar matter in the system similar to a jet which is throwed away from the primary. The decrease of the light change amplitude with increasing λ is probable connected with the geometry of the components, the latter is supported by the behaviour of the limited Fourier row. Probably there is the "third" light – a cool cloud which the W UMa systems are dipped in. However, the observations at $\lambda > 2.2$ μm are needed to sort the matter out.

SHENAVRIN V.I.

Sternberg Astronomical Institute,
Crimean Station, Crimea

ZHUKOV G.V.

Kazan University, Department of
Astronomy
Kazan 8, ul. Lenina 18
U.S.S.R.

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HD 91948: A NEW PROBABLE Be STAR

Gorga (1971) investigated the binary nature of the star HD 91948 (=BD+60° 1274 = SAO 15243; F8V). He found it to be a spectroscopic binary with an orbital period of $2^{d}.7700266$. The first photoelectric (UBV) observations were carried out by Padalia (1980) from May 1973 to May 1978 on 17 nights to see its variable (eclipsing binary) nature. However, Padalia (1980) found the variability of this star only on two nights (falling at phases $0^{d}.09$ and $0^{d}.25$), though the star had been observed almost in the entire phase region. It was concluded that the star was a suspected variable and not an eclipsing binary. From his photoelectric observations he determined its spectral type to be AOV.

The UBV observations of this star taken by Padalia on one of the two nights, 21 March 1977 (JD 2443224) at phase near $0^{d}.25$ showed a variation of $0^{m}.26$ in U, $0^{m}.15$ in B and $0^{m}.10$ in V filter (Figure 1). However, the variation was not repeated at the same phase on other nights which indicated that the light variation of HD 91948 was not of eclipsing nature. It is clear from Figure 1 that the variation in U is larger than that in B and V. Similar type of photoelectric variation has been observed in Be stars, for example 88 Her and Pleione (Magalashvili and Kumsishvili, 1982). The variation found in different colours for HD 91948 and 88 Her are as follows:

Star	Filters			
	U	B	V	
HD 91948	$0^{m}.26$	$0^{m}.15$	$0^{m}.10$	(Padalia, 1980)
88 Her	0.14	0.10	0.07	(Magalashvili and Kumsishvili, 1982)
88 Her	0.30	0.15	0.15	(Harmanec et al., 1978)

In order to investigate the Be nature of this star we have carried out spectrophotometric observations.

The star was observed by us on the night of 29 April 1984 on the 104-cm reflector of the Uttar Pradesh State Observatory. A Hilger and Watts mono-

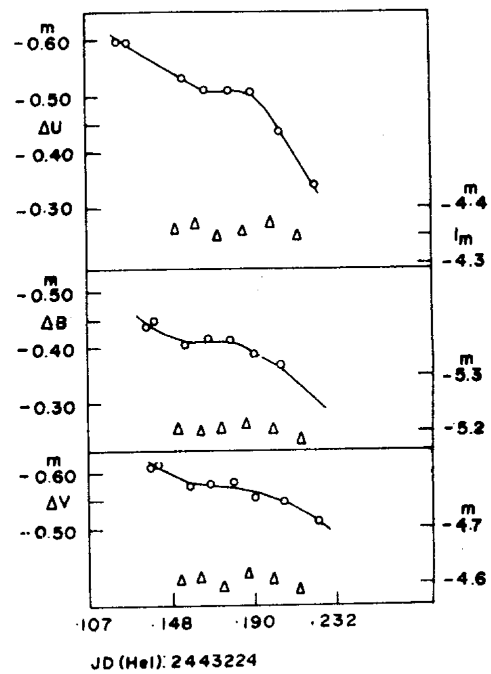

Figure 1

Individual observations on the night of JD 2443224 (Padalia, 1980). The differential magnitudes are in the sense variable minus comparison. The solid line indicates free hand curve. Points with Δ are instrumental magnitudes for comparison star used.

chromator was used for taking spectral scans. The standard star α Leo and the comparison star BD +60^{o} 1289 = HD 93286 (which was also used for our earlier UBV observations) was observed along with the variable star. We noticed that the H_α line of variable star was found to be filled-in by emission (Figure 2). An inspection of Figure 2 reveals that the standard and the comparison stars have H_α lines in absorption whereas the variable star has no absorption lines. We have also observed H_β, H_γ, H_δ, H_ϵ etc. lines and found that these lines are in absorption for the standard and the comparison stars used by us, but these absorption lines fade away for HD 91948.

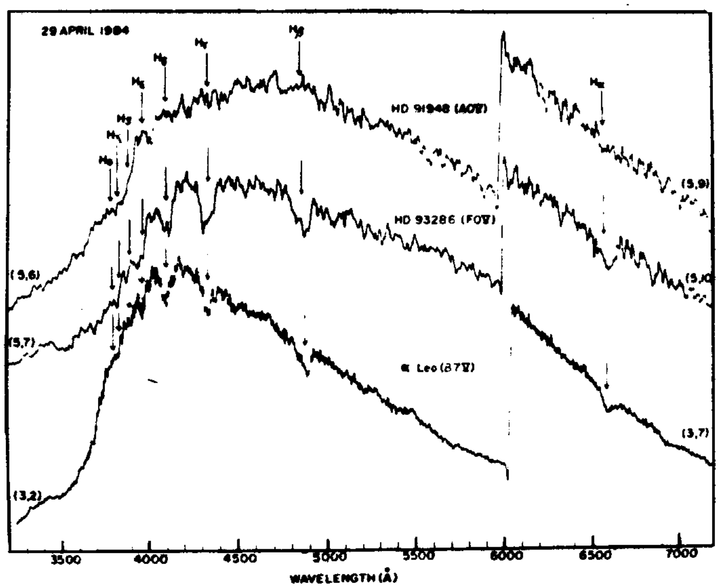

Figure 2

Spectrophotometry of HD 91948 along with the standard and comparison stars. The Balmer lines are shown by vertical arrows. The amplifier sensitivities used for various stars are indicated by numbers inside brackets. The sharp discontinuity in the spectrum at a wavelength of λ 6000 Å is due to change in sensitivities.

From this we infer that HD 91948 is an emission line (Ae) star. Further UBV and scanner observations are in progress.

P.S. GORAYA and T.D. PADALIA

Uttar Pradesh State Observatory,
Manora Peak, Naini Tal-263129,
India

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HD 8358 AND HD 106225: TWO NEW VARIABLE STARS

We began photometry and spectroscopy because there was spectroscopic evidence that they are chromospherically active stars of the RS CVn or BY Dra type. Bidelman (1981) reported spectral type G and slightly fuzzy spectral lines (suggestive of rapid rotation) for HD 8358 and spectral type gK and strong Ca II H and K emission (evidence of strong chromospheric activity) for HD 106225. HD spectral types and approximate V magnitudes are G0 and $8^m.43$ for HD 8358 and K0 and $8^m.1$ for HD 106225.

Photometry was obtained in the UBV bandpasses with the 48-inch telescope at Cloudcroft Observatory and with the 30- and 36-inch telescopes at McDonald Observatory. The comparison star was SAO 109848 for HD 8358 and SAO 138628 for HD 106225. Radial velocity measures were obtained for

Table I

Photometry of HD 8358

JD(hel.)	ΔV	ΔB	ΔU
2445153.949	-1.007	-	-
167.970	-0.999	-	-
168.946	-0.897	-1.124	-
187.866	-0.865	-1.106	-
188.959	-0.857	-1.089	-
191.948	-0.953	-	-
320.664	-0.937	-1.190	-1.653
321.614	-0.941	-1.200	-1.676
325.607	-1.003	-1.274	-1.762
327.608	-0.931	-1.188	-1.656
332.612	-0.946	-1.196	-1.667
337.616	-0.991	-1.260	-1.744
338.624	-0.994	-1.264	-1.748
339.620	-0.968	-1.234	-1.717
340.599	-0.894	-1.149	-1.620
341.616	-0.874	-1.115	-1.580
342.631	-0.861	-1.103	-1.564
343.624	-0.879	-1.123	-1.589
344.649	-0.891	-1.140	-1.604
345.611	-0.943	-1.203	-1.662
357.626	-0.911	-1.168	-1.631
360.619	-0.950	-1.206	-1.696
2445361.615	-0.958	-1.217	-1.687

Table II

Photometry and Spectroscopy of HD 106225

JD(hel.)	ΔV	ΔB	JD(hel.)	V_r
2445110.713	0.566	0.489	2444736.764	− 7.0
111.695	.588	.516	737.665	+13.3
113.696	.688	.623	738.685	+35.0
116.674	.834	–	2444739.757	+45.7
119.677	.631	–	2445075.814	−20.4
120.685	.577	–	076.786	−37.1
121.689	.600	–	077.814	−40.2
128.671	.811	–	078.762	−29.6
141.689	.577	–	079.834	+ 0.5
146.639	.726	–	356.994	−41.1
2445153.639	.604	–	358.929	−41.7
			360.922	+ 8.2
			361.954	+34.6
			717.980	+21.9
			720.000	−27.8
			2445721.990	−51.8

HD 106225 at Kitt Peak National Observatory. The data are presented in Tables I and II. For the photometry Δ means variable minus comparison, the differential magnitudes have been corrected for differential extinction and transformed differentially to the UBV system, and each value is a nightly mean of three separate differential measures between variable and comparison. Before JD 2445200 the photometry was obtained at Cloudcroft; after that date it was obtained at McDonald.

When the ΔV data for HD 8358 were analyzed by the method of Lafler and Kinman (1965), no satisfactory period was found. In subsequent analysis we excluded the six (Cloudcroft) nights which were obtained 130 days earlier than the other (McDonald) nights; the result was three periods which gave comparably good fits: $0^{d}.520 \pm 0^{d}.001$, $1^{d}.805 \pm 0^{d}.002$, and $12^{d}.75 \pm 0^{d}.25$. Because the McDonald observations were made at very nearly the same time of night each night, i.e., they are separated by very nearly integral multiples of a day, we suspected those three values might be beat periods of each other. This is probably so, because they are related by the expression

$$\frac{1}{0.520} - 1 \approx \frac{1}{1.085} = 1 - \frac{1}{12.75}$$

to within their respective uncertainties. The early (Cloudcroft) photometry was not able to resolve the ambiguity, because it gave equally good light curves with all three periods. We also point out that its light curve shape was significantly different from that given by the McDonald photometry, and that the 130-day gap separating the two was too long to let the two be phased together reliably.

In Figure 1 we plot the McDonald photometry from Table I versus phase computed with the ephemeris

$$JD\ (hel.) = 2445214.7 + 0\overset{d}{.}520\ n\ ,$$

where the initial epoch is arbitrary and the value of the period is not necessarily preferred over the other two. The total amplitude of the light variation is $0\overset{m}{.}14$ in V and the shape is noticeably asymmetric.

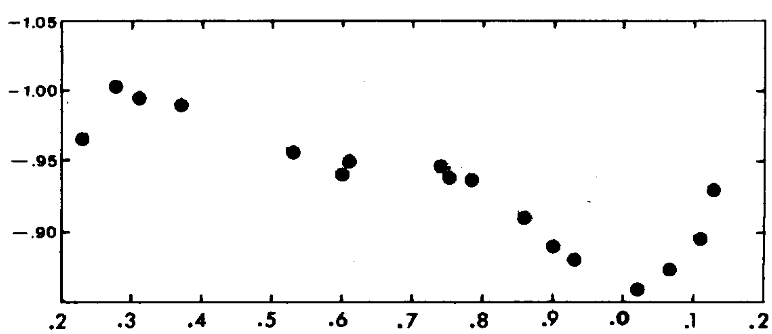

Figure 1

When the ΔV data for HD 106225 in Table II were analyzed with the method of Lafler and Kinman (1965), the best light curves were obtained with periods of $0\overset{d}{.}91 \pm 0\overset{d}{.}01$ and $10\overset{d}{.}6 \pm 0\overset{d}{.}1$. As with HD 8358, because the data were obtained at nearly integral-day multiples, we suspected these two values are beat periods of each other. Indeed they are related by the expression

$$\frac{1}{10.6} = \frac{1}{0.91} - 1$$

to within their respective uncertainties.

When the radial velocity data for HD 106225 in Table II were analyzed with the method of Lafler and Kinman (1965), the best fits were obtained with periods of $6\overset{d}{.}851 \pm 0\overset{d}{.}001$ and $10\overset{d}{.}389 \pm 0\overset{d}{.}001$. We are inclined to rule out the smaller of these, because it produces a radial velocity curve very skewed in shape and hence indicative of an unreasonably large orbital ec-

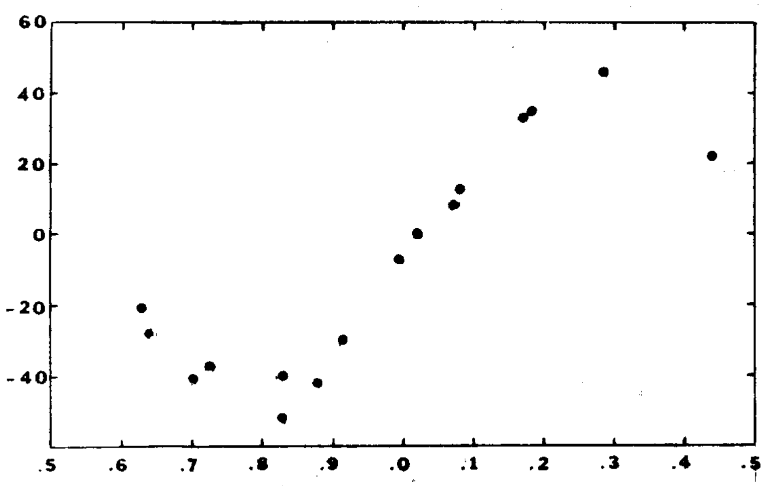

Figure 2

centricity. Figure 2 is a plot of the radial velocity values in Table II versus phase computed with the ephemeris

$$\mathrm{JD(hel.)} = 2445214.7 + 10^{\mathrm{d}}.389\ n\ ,$$

where the initial epoch is arbitrary.

The Ca II H and K emission observed in HD 106225 makes us think it probably is an RS CVn binary. In most RS CVn binaries photometric variability results from rotational modulation as one of the two stars, its surface darkened unevenly by large-scale spot activity, rotates approximately synchronously with the orbital period. Consequently we believe the photometric (rotational) period should be close to the spectroscopic (orbital) period and on that basis prefer $10^{\mathrm{d}}.6$ rather than $0^{\mathrm{d}}.91$ as the correct photometric period. Figure 3 is a plot of the ΔV values from Table II versus phase computed with the ephemeris

$$\mathrm{JD(hel.)} = 2445214.7 + 10^{\mathrm{d}}.60\ n\ ,$$

where the initial epoch is arbitrary. The total amplitude of the light variation is approximately $0^{\mathrm{m}}.25$ in V and the shape is very nearly sinusoidal. Comparing the photometric period ($10^{\mathrm{d}}.6 \pm 0^{\mathrm{d}}.1$) with the spectroscopic period ($10^{\mathrm{d}}.389 \pm 0^{\mathrm{d}}.001$), we see the rotation is synchronized with the orbital motion to within 2.0% ± 1.0%.

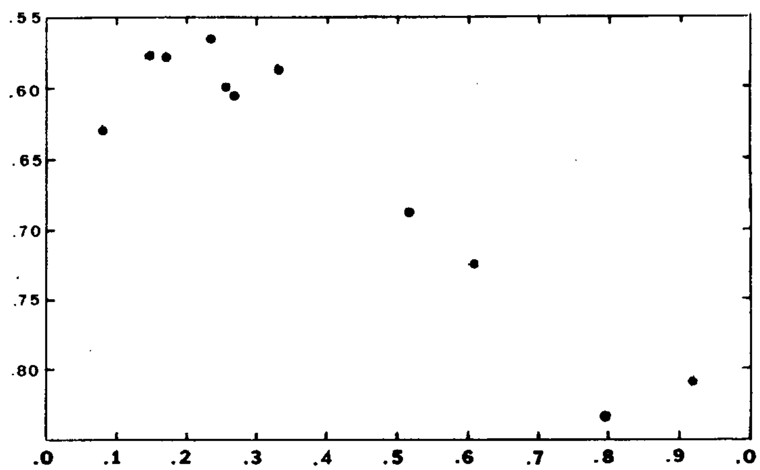

Figure 3

For HD 8358 we need more photometry, obtained throughout a single night, to determine whether $0^{\mathrm{d}}.52$ or $1^{\mathrm{d}}.083$ or $12^{\mathrm{d}}.75$ is the correct period; and we need radial velocity data to determine whether it is a close binary or a rapidly rotating single star. For HD 106225 we need more photometry, over a longer baseline of time, to improve the precision of the photometric period.

FRANCIS C. FEKEL
DOUGLAS S. HALL

Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

GREGORY W. HENRY

McDonald Observatory
Fort Davis, Texas 79734

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**EVIDENCE FOR THE VARIABILITY OF HD 5210:
A COMPARISON STAR FOR HD 5303**

We wish to alert photometric observers of the southern RS CVn system HD 5303 that the frequently used comparison star HD 5210 may be a variable. This suspicion arises from photometry we carried out on HD 5303 in the period 1983 September to December as part of an international programme. We made 77 measurements in B and V relative to HD 5499 and 63 relative to HD 5210. On two nights, HD 6446 was also included as a comparison star in V.

The usual observing cycle was HD 5499 → sky → HD 5303 → sky → HD5210 → sky → HD 5303 → sky → HD 5499 → etc.

We found that $V_{HD\ 5499} - V_{HD\ 6446}$ on these two nights was 0.526 ± 0.005, in agreement with our earlier finding of 0.529 ± 0.008 (Coates et al, 1983). However the average nightly magnitude differences $V_{HD\ 5499} - V_{HD\ 5210}$ vary by up to 0.05 magnitude, from 2.00 to 2.05, which is significantly greater than our usual observational uncertainties.

This raises the possibility that one or both of HD 5499 and HD 5210 may be variable. We therefore re-examined our earlier data on HD 5303, which included HD 5499 (Coates et al, 1983). In that paper we concluded from 250 measurements in V taken over 16 months that HD 5499 did not vary by more than 0.008 magnitude, which is strong evidence for the constancy of this star. At that time we did however conclude that $V_{HD\ 5499}$ is 6.65, rather than 6.69 as given by Cousins et al, 1966. This was because our measured magnitude differences between HD 5499, HD 6446 and HD 661 were consistent if the values given by Cousins et al:

$$V_{HD\ 6446} = 7.18$$

$$V_{HD\ 661} = 6.63 \text{ or } 6.64$$

were correct, but $V_{HD\ 5499}$ were 6.65 rather than 6.69.

We have now looked for other photometric results on these stars, and have found the following:

HD 5499

V = 6.69 (Eggen, 1976)

V = 6.685 (Rucinski, 1983)

Table I

HJD	$V_{HD\ 5210} - V_{HD\ 5499}$	$B_{HD\ 5210} - B_{HD\ 5499}$
2440000+		
5590.187	2.003	1.628
.207	1.999	1.625
.230	1.998	1.621
.245	1.998	1.620
.258	1.999	1.621
5592.125	1.999	-
5593.162	1.997	1.619
.175	1.997	1.621
.190	2.003	1.628
.205	2.006	1.625
.218	2.008	1.628
.232	2.004	1.626
.245	2.005	1.630
.258	2.001	1.626
.266	1.995	1.613
5604.170	2.000	1.614
.183	2.007	1.623
.194	2.011	1.629
.206	2.010	1.627
.220	2.012	1.626
.235	2.023	1.636
.251	2.034	1.645
.266	2.036	1.643
5609.164	2.010	1.627
.176	2.017	1.625
.189	2.026	1.628
.201	2.027	1.631
.216	2.025	
5613.169	2.031	1.630
.182	2.059	1.653
.196	2.053	1.653
.209	2.025	1.640
.225	2.025	1.644
.241	2.022	1.642
.255	2.007	1.628
5616.194	2.005	1.626
.224	2.019	1.638
.244	2.014	1.630
5617.200	2.046	1.667
.216	2.052	1.673
5650.027	2.019	1.627

HD 6446

$V = 7.22$ (Eggen, 1976)

HD 5210

$V = 8.691$ (Rucinski, 1983)

$V = 8.71$ (Collier et al, 1981)

$V = 8.72$ (Collier, private communication)

On all this evidence, $V_{HD\ 5499}$ is probably constant at 6.69, $V_{HD\ 6446}$ is 7.22, $V_{HD\ 661}$ is 6.67, and $V_{HD\ 5210}$ may vary between about 8.69 and 8.74. After eliminating all even slightly doubtful data (due to possible cloud, interference by the moon, etc.) from our measurements of $V_{HD\ 5499}$ and $V_{HD\ 5210}$ we still find convincing evidence for variations up to 0.05 magnitude.

We have searched the differences $V_{HD\ 5210} - V_{HD\ 5499}$ and $B_{HD\ 5210} - B_{HD\ 5499}$ for periodicities by producing light curves for selected periods. There is weak evidence for eclipses in HD 5210 at a period of about 1.44 days, but this is not convincing. With these data other frequencies are possible. We shall carry out photometry later this year to try and resolve this problem. We give our data for the magnitude differences HD 5210 - HD 5499 in the table.

J.L. INNIS, D.W. COATES and K. THOMPSON
Department of Physics, Monash University,
Clayton, Victoria, 3168, Australia.

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TIMES OF MINIMA OF ECLIPSING VARIABLES - III

This bulletin lists times of minima determined at this observatory in 1980, 1981 and 1983, as a continuation of the program for which results were previously published in I.B.V.S. No. 844 (1973) and I.B.V.S. No. 1379 (1978). The present observations were obtained with a larger telescope of 0.5 m aperture and with a new photometer designed and constructed by J.R. Stilburn. This photometer provides automatic sky subtraction by means of a rocking mirror, and by advancing the filter wheel several (normally 10) full cycles for each integration, permits essentially simultaneous observations in several colours. For the present observations a set of Johnson UBV filters was used, and times of minima determined independently for each of the three filters. As before, these were obtained by the method of Kwee and van Woerden

Table l

Observed Times of Minima

Star	HJD [2,440,000+]	E	O-C (days)	Observer
KO Aql	4450.7980 ± .0006	1430	.0308	F
	5524.8317 ± .0008	1805	.0558	F
OO Aql	4460.8016 ± .0010	7108.5	.0166	D
	4476.7681 ± .0009	7140	.0193	B
	4832.7879 ∓ .0006	7842.5	.0214	F
44i Boo	4366.7971 ± .0010	21856	.0318	D
	4390.9032 ± .0022	21946	.0346	D
	4409.7855 ± .0015	22016.5	.0360	B
	4811.7794 ± .0035	23517.5	.0406	S
	5473.8187 ± .0008	25989.5	.0430	G
	5476.9019 ± .0006	26001	.0463	G
	5477.8383 ± .0006	26004.5	.0453	G
	5478.7745 ± .0009	26008	.0442	F
	5488.8162 ± .0011	26045.5	.0429	G
ZZ Boo	4363.8527 ± .0016	1161.5	.0228	S
RZ Cas	4470.8530 ± .0008	12211	-.0020	F
	4831.8169 ∓ .0001	12513	-.0028	S
VW Cep	4427.7968 ± .0008	18192.5	.0165	D
	4455.7641 ± .0020	18293	.0132	S
	4455.9072 ± .0025	18293.5	.0172	S
	4457.8538 ± .0028	18300.5	.0156	F
	4470.7931 ± .0005	18347	.0133	F

Table I (cont.)

Star	HJD [2,440,000+]	E	O-C (days)	Observer
VW Cep	4788.7666 ± .0007	19489.5	.0134	F
	4812.8423 ± .0005	19576	.0149	F
	4822.8616 ± .0005	19612	.0149	F
	4824.8097 ± .0006	19619	.0148	F
	4834.8279 ± .0010	19655	.0137	F
	5507.7873 ± .0011	22073	.0105	S
	5562.7544 ± .0005	22270.5	.0107	F
	5562.8940 ± .0013	22271	.0111	F
MR Cyg	4480.7613 ± .0012	6609.5	.0007	D
	4833.7777 ± .0012	6820	.0015	S
V1073 Cyg	5568.8845 ± .0010	8775.5	-.0028	G
AI Dra	4371.7552 ± .0011	5695	-.0069	F
	4769.7619 ± .0006	6027	-.0068	F
	5478.8653 ± .0061	6618.5	-.0026	F
	5481.8597 ± .0006	6621	-.0052	F
TW Dra	4360.8447 ± .0012	2074	.0228	F
S Equ	5544.9246 ± .0009	2205	.0420	F
Z Her	4413.8677 ± .0008	7846	.0015	D
	4433.8286 ± .0008	7851	-.0016	D
RX Her	4813.8251 ± .0014	6990.5	.0030	F
	4821.8271 ± .0006	6995	.0015	S
	4829.8294 ± .0008	6999.5	.0002	S
TX Her	4362.8122 ± .0009	6815	.0122	F
	4809.7966 ± .0007	7032	.0181	S
	5499.8294 ± .0023	7367	.0148	G
	5532.7877 ± .0019	7383	.0161	G
AK Her	5480.8681 ± .0011	16486.5	-.0041	G
CM Lac	4446.8435 ± .0003	10856	-.0022	F
	4458.8775 ± .0012	10863.5	-.0034	F
	4828.7630 ± .0003	11094	.0007	F
	5571.7352 ± .0004	11557	.0008	G
FL Lyr	4459.7830 ± .0011	2482	.0067	S
	5572.8218 ± .0010	2993	.0104	G
U Oph	4371.9307 ± .0008	21517.5	-.0049	F
	4408.8336 ± .0007	21539.5	-.0036	B
	4429.8037 ± .0010	21552	-.0003	D
	4793.7895 ± .0008	21769	.0014	S
	5479.8250 ± .0009	22178	.0024	S
V502 Oph	4370.8684 ± .0007	10434.5	-.0044	F
V566 Oph	4406.8073 ± .0007	6276	.0092	D
	4448.7922 ± .0013	6378.5	.0055	F
	4780.8121 ± .0005	7189	.0075	S
	4781.8357 ± .0005	7191.5	.0070	F
	5512.8463 ± .0006	8976	.0049	F
	5513.8700 ± .0007	8978.5	.0045	G
EE Peg	4475.8140 ± .0014	1960	.0173	D
	5546.8202 ± .0025	2367.5	.0288	G
	5563.8916 ± .0016	2374	.0168	G
	5567.8399 ± .0039	2375.5	.0228	G
U Sge	4827.8181 ± .0002	8193	-.0036	F

Observers: B = D.J. Barlow D = P.A. Delaney F = D.W. Forbes
G = J. Gagné S = C.D. Scarfe

(BAN 12, 327, 1956), the program was modified in 1983 for interactive use by one of us (D.W.F.). The results listed in Table I are averages of the minima from each colour (excluding U if it was strongly discordant), and the uncertainties are the larger of

a. the root-mean-square value of the errors determined by the program for each colour

b. the standard error of one determination from the interagreement between the times of minimum in each colour.

The ephemerides used to calculate O-C were the same as those used in I.B.V.S. No. 844 and No. 1379. For stars not previously observed ephemerides are given in Table II. For TX Her the ephemeris in I.B.V.S. No. 1379 is incorrect, it should read P.Min. = 2430325.2006 + 2.05980915 E. Remarks on individual stars follow the table.

Table II Ephemerides

Star	HJD [2,400,000+]	Period	References
KO Aql	40355.2140	2.8640232	Hayasaka, PASJ 31, 271, 1979
V1073 Cyg	38672.5816	0.7858597	Kondo, AJ 71, 54, 1966
TW Dra	38539.4457	2.8068352	Pohl, IBVS 443, 1970
S Equ	37968.3438	3.436072	Plavec, BAC 15, 25, 1964
FL Lyr	39053.6060	2.17815081	Monske, IBVS 119, 1965
V502 Oph	39639.9431	0.45339304	Binnendijk, AJ 74, 222, 1969

Notes on individual systems:

1. KO Aql

Our observations and those of Olson (I.B.V.S. No. 1938, 1981) and Margrave (I.B.V.S. No. 1869, 1980; I.B.V.S. No. 1930, 1981; I.B.V.S. No.2086, 1982; I.B.V.S. No. 2292, 1983) all indicate that since 1979 the rate of increase in the period has been less than found from earlier data by Hayasaka (1979), whose ephemeris includes the term + $2.00 \times 10^{-8} E^2$.

2. OO Aql

Our observations show increasing positive residuals from the ephemeris of Herczeg (I.B.V.S. No. 699, 1972). This trend may be accelerating, according to the recent observation of Pohl et al., (I.B.V.S. No. 2385, 1983).

3. 44i Boo

The residuals from the ephemeris of Pohl (I.B.V.S. No. 209, 1967) continue to increase, possibly at an accelerating rate.

4. VW Cep

Our results, together with others in the literature, indicate little departure from the period of Scarfe and Brimacombe (AJ 76, 50, 1971) that cannot be interpreted as a light-time effect in the triple system (Hershey, AJ 80, 662, 1975). The most recent observations, however, do suggest a new decrease in the period. The observations of Mahdy and Soliman (I.B.V.S. No. 2153, 1982) are anomalous, giving large positive residuals.

5. TX Her

The most recent minima favour the quadratic ephemeris of van Hamme (A. and Ap. 107, 409, 1982) over his linear and periodic ephemerides.

6. V566 Oph

The last entry in Table I of I.B.V.S. No. 1379 should have E = 2812. Our observations and those of Pohl and Gülmer (I.B.V.S. No. 1924, 1981) and Pohl et al., (I.B.V.S. No. 2385, 1983) disagree with those of Mahdy and Soliman (I.B.V.S. No. 2154, 1982) and Niarchos (I.B.V.S. No. 2451, 1983) in showing positive residuals from the ephemeris given in I.B.V.S. No. 1379.

C.D. SCARFE
D.W. FORBES
P.A. DELANEY
J. GAGNE

Climenhaga Observatory
University of Victoria
Victoria, B.C., Canada

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FIVE BRIGHT NEW VARIABLE STARS

We report UBV photometry obtained during the first quarter of 1984 with the 10-inch automatic photoelectric telescope at Fairborn Observatory West in Phoenix, Arizona, which shows five bright stars to be variable: HR 4430, HD 25893, HD 28591, HD 116204, and HD 136901.

We suspected variability because all five have characteristics which marked them as possible RS CVn binaries. HR 4430 is a known SB1 (Northcott 1947) containing a late-type giant. The other four, though not known binaries, were of late spectral type and Bidelman (1983) reported Ca II H and K in emission. Heard (1956) did, however, report "variable velocity" for HD 136901 on the basis of nine radial velocity measures. HD 116204 was included in the list of 20 suspected variables published by Hall (1983).

Table I lists the approximate V magnitude of each variable, the comparison star we used, the spectral type, and the source of the spectral type.

Table I

Star	V	Comparison	Sp. Tp.	Source
HR 4430	$6^m.4$	HD 101133	K2 III	Y.B.S.C.
HD 25893	7.1	HD 25975	G5	HD
HD 28591	6.7	HD 28620	G5	HD
HD 116204	7.2	HD 116010	K2	HD
HD 136901	7.4	HD 136643	K1 III	Heard (1956)

Our photometry is described by Boyd, Hall, and Genet (1984) and the data have been sent to the I.A.U. Commission 27 Archive for Unpublished Data on Variable Stars (Breger 1982) where they are available as file no. 136 . HD 25893 is ADS 2995 but, since the two visual components are separated by only about 1.5 arcseconds, both components were included in the diaphragm during photometry.

We determined photometric periods by estimating times of well-defined minima and maxima and using least squares to fit those times with a linear ephemeris. If maxima did not occur midway between successive minima, we shifted their times accordingly by a constant amount. For HD 28591 we added $4^{\mathrm{d}}.0$ to times of maxima; for HD 116204 we subtracted $3^{\mathrm{d}}.0$. The resulting ephemerides are given in Table II, where integer values of n refer to minimum light and half-integer values of n refer to maximum light.

Table II

Star	Ephemeris	V
HR 4430	2445704.1 + $39^{\mathrm{d}}.0$ n	$0^{\mathrm{m}}.13$
	±2.2 ±1.3	
HD 25893	2445701.0 + 7.37 n	0.03
	± .4 ± .06	
HD 28591	2445698.9 + 21.3 n	0.07
	±1.0 ± .4	
HD 116204	2445700.3 + 21.7 n	0.06
	± .5 ± .2	
HD 136901	2445705.9 + 9.63 n	0.16
	± .2 ± .05	

Light curves are plotted in Figures 1 through 5. Each point is a mean of three individual observations of the variable, each of these three flanked by comparison star measures; each mean corresponds to one line in

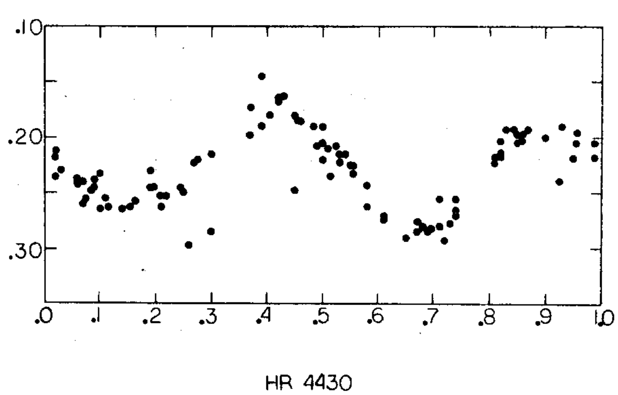

Figure 1
Light curve of **HR** 4430 .

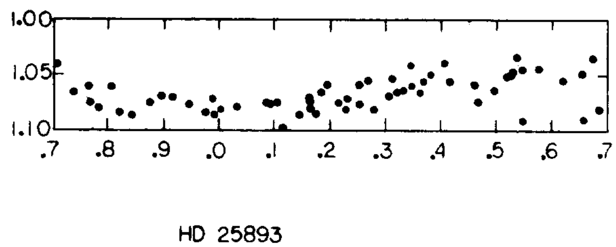

Figure 2
Light curve of HD 25893.

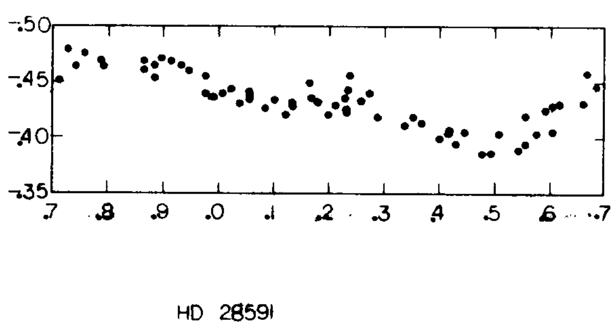

Figure 3
Light curve of HD 28591.

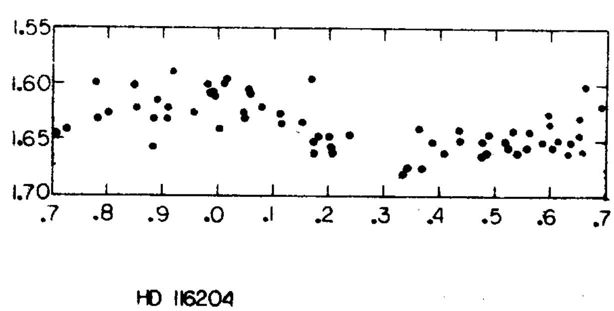

Figure 4
Light curve of HD 116204.

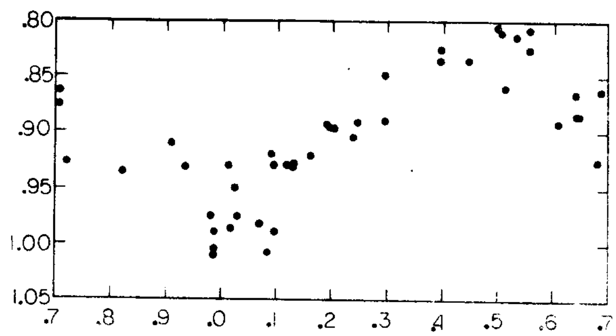

Figure 5
Light curve of HD 136901.

file no. 136 . Except for one case, phases are computed with the ephemerides in Table II. For HR 4430 the photometric period is very nearly half the spectroscopically determined orbital period of Northcott (1947), so we used her ephemeris

$$JD(hel.) = 2430852.014 + 74\overset{d}{.}861\ n\ ,$$

where the initial epoch is a time of periastron. The approximate total range of the brightness variation in V is given in the last column of Table II. The corresponding ranges in B and U are similar.

Because Lucy and Sweeney (1971) judged the orbit of HR 4430 circular, we ignored the eccentricity and estimated a time of conjunction (the K1 III star behind) to be JD 2430826.0 ± $1\overset{d}{.}0$. Extrapolating this forward to the epoch of our photometry, we concluded that the two minima seen in Figure 1 coincide with the two conjunctions and the two maxima coincide with the two quadratures, all to within the cumulative uncertainty of about ± $0\overset{P}{.}05$. Such a light curve could be a result of ellipticity and/or shallow eclipses, similar to that of the giant eclipsing binary 5 Ceti (Lines and Hall 1981). On the other hand, we note that the two maxima are not equally bright and the two minima are not equally faint, suggesting similarity to the double - humped light curve of the RS CVn binary HD 185151 (Bopp et al. 1982), although the absence of Ca II H and K emission (Lloyd-Evans 1977) suggests HR 4430 is not an RS CVn binary.

The other four stars, because of the Ca II H and K emission, probably are RS CVn binaries. Therefore the photometric periods in Table II are probably rotational periods for the brighter star in each, which we presume are unevenly darkened with starspots. Moreover, since rotation in virtually all known RS CVn binaries is synchronous to within a very few percent, these photometric periods provide useful estimates of what future spectroscopic observations may prove the orbital period to be.

LOUIS J. BOYD

Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET

Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL

Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

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HR 3337 : A BRIGHT NEW ECLIPSING BINARY

UBV photometry obtained during the first quarter of 1984 with the 10 - inch automatic photoelectric telescope at Fairborn Observatory West in Phoenix, Arizona shows that HR 3337 is probably an eclipsing binary.

HR 3337 is the visual binary ADS 6828. According to Batten, Fletcher, and Mann (1978) one component is an SB1, with P(orb.) = $5^{d}.9766$; the other component is another SB1, with P(orb.) = $2^{d}.49955$. Because the separation between components A and B is only 0.4 arcseconds, our photometry included both (as well as component C, 18 arcseconds away) in the diaphragm. According to the Yale Bright Star Catalogue, components A and B differ in brightness by only $0^{m}.1$, the composite magnitude is V = $6^{m}.39$, and the composite spectral type is A5m.

We suspected variability because Grønbech and Olsen (1976) concluded it might be "variable in V," on the basis of the scatter in three separate photoelectric measures. HR 3337 was included in the list of 20 suspected variable stars published by Hall (1983).

Our photometry is described in detail by Boyd, Genet, and Hall (1984) and the data have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1982), where they are available as file no. 136. Our comparison star was HD 71297.

When our differential magnitudes were plotted with respect to phase computed with the ephemeris

$$JD(hel.) = 2442884.158 + 2^{d}.49955\ n$$

given by Batten, Fletcher, and Mann (1978), where the initial epoch is a time of periastron, there was evidence of a shallow eclipse around phase $0^{P}.48$. This phase corresponds to a time of conjunction (the spectroscopic primary component in front) to within about $0^{P}.05$, which is approximately the uncertainty to be expected in extrapolating forward to the epoch of our observations.

Figure 1 is a plot of all data in the phase interval between $0\overset{P}{.}4$ and $0\overset{P}{.}5$. The arrow indicates the mean level of brightness as defined by all the other (non eclipse) points. The eclipse we see is approximately $0\overset{m}{.}06$ deep in all

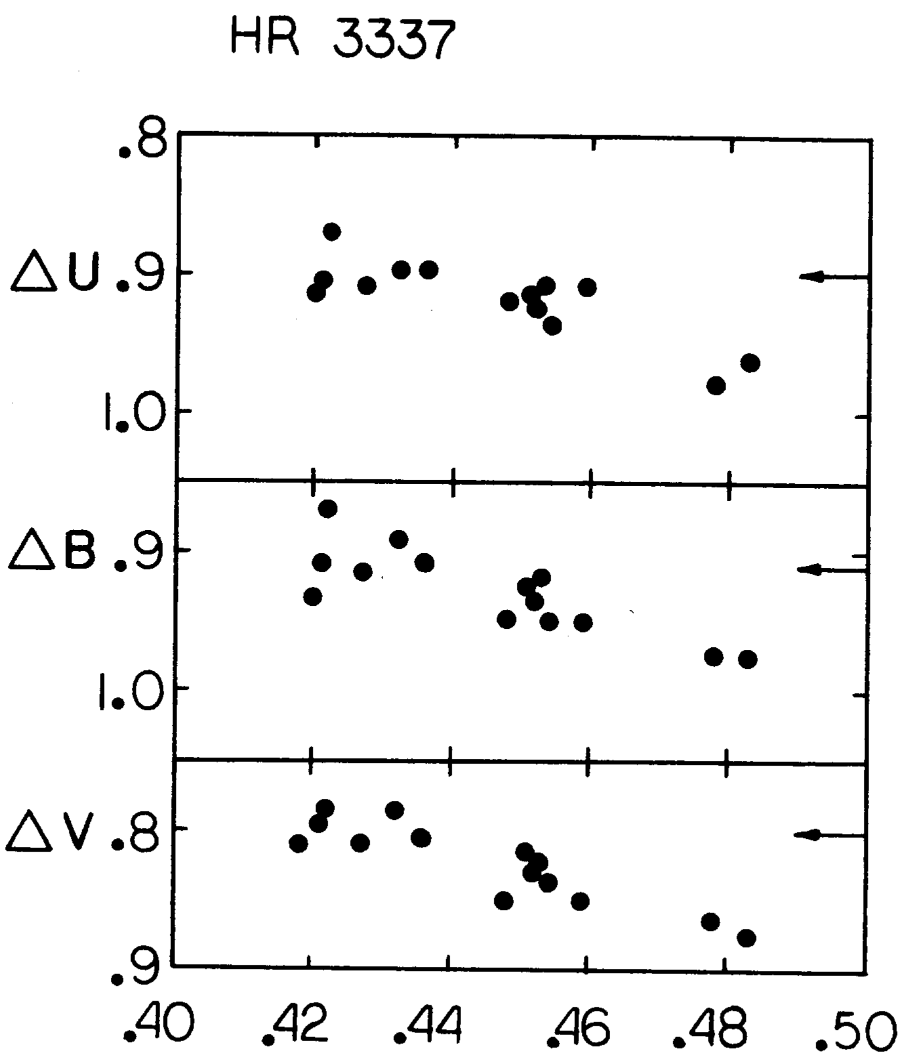

Figure 1

The arrows indicate the mean level outside eclipse. The points below define the shallow secondary eclipse we have discovered.

three bandpasses, but it could be deeper if the lowest points do not define the bottom. We obtained no data in the corresponding phase interval a half cycle away, where the other eclipse should fall. Fekel (1978) states that the secondary star is "late F." Therefore the eclipse we have observed, when the (earlier) primary star was in front, must be the secondary eclipse.

LOUIS J. BOYD

Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET

Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL

Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

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DETECTION OF AN ULTRAVIOLET CONTINUUM IN T Lyn

T Lyn is an N-type carbon star classified as a Mira variable with a period of about 420 days and a range $9.0<V<13.3$. On a 75 minute exposure, low-dispersion Kodak IIIa-J objective-prism plate, taken with our Burrell Schmidt telescope on 1 Feb. 1984, this star, which was near maximum light, shows a heavily exposed continuum sharply tapering off towards a wavelength of about 4000 Å, below which a faint, flat featureless ultraviolet continuum persists down to the blue spectral cut-off at about 3300 Å. Inspection of the Palomar Observatory Sky Survey print shows that this ultraviolet tail can not be caused by an overlapping spectrum. It could arise in a hot, blue companion ($U \sim 16$ mag) or in T Lyn itself as proposed in the similar case of NQ Gem (Ap.J. 163, 309, 1971). Additional observations are obviously needed to define the source of this ultraviolet continuum. Observations with the IUE satellite would be ideal but would, unfortunately, require very long exposure times.

N. SANDULEAK
Warner & Swasey Observatory
Case Western Reserve University
Cleveland, OH 44106 U.S.A.

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SPECTRAL TYPES OF ECLIPSING BINARIES

37 eclipsing binaries were observed by the author utilizing the 2.1-m telescope and image-intensified White spectrograph of the Kitt Peak Observatory. 46 Å mm^{-1} was achieved on forming gas baked IIIa-J plates in the second order blue. The spectra were well-exposed from nearly H12 to the Na I D-lines near 5900 Å. With the exception of V766 Sgr (which was underexposed), all plates were of good quality. The spectrum of each star was visually classified by comparison with the MK classes of known standard stars. Table I contains

Table I

Spectral Types

Variable	UT Date (1983)	SP. Type	Previous SP. Type
UU And	Jul 17.472	A8IV/V	F5
XZ And	Jul 18.463	A1 V	A0, A4 IV, A4 V
CZ Aqr	Jul 18.451	A7 V	A5
YZ Aql	Jul 17.251	A2 III	A3
V343 Aql	Jul 16.362	A0 V	A2, A0 V, B9 V
TY Cap	Jul 17.347	A2/3 V	A5
AQ Cas	Jul 18.457	B3 V	B3 + B9
FV Cas	Jul 17.460	A0 V	—
BB Cep	Jul 17.447	F1 V	G0
KV Cyg	Jul 17.340	B1 V	B0
V687 Cyg	Jul 16.343	A0 V	A1
V698 Cyg	Jul 16.369	A7 IV	B2
V728 Cyg	Jul 16.404	A0 V	A0
TT Del	Jul 16.432	A1 V	A1
AV Del	Jul 16.439	F8 V	F8
BS Del	Jul 16.451	G0 V	—
SZ Her	Jul 18.145	F0 V (comp)	A0, A3, A5, F0 V, F4 V
TU Her	Jul 16.219	F0 III/IV	F5
BO Her	Jul 16.326	A7 V	A7
CC Her	Jul 18.159	A1 V (p Sr)	A0
CT Her	Jul 16.206	A3 V	A0, A3 V
TW Lac	Jul 17.438	A3 IV	A2
RV Lyr	Jul 16.335	A3 V	A
EW Lyr	Jul 16.291	A8/9 V	F0
SW Oph	Jul 16.187	A3 V	A0
SZ Oph	Jul 16.226	A9 III	A
V535 Oph	Jul 17.231	B9 V(p)	A3
UX Peg	Jul 18.444	G5 V	A2
SX Psc	Jul 17.479	A7 V	F1

Table I (cont.)

Variable	UT Date (1983)	SP. Type	Previous SP. Type
UZ Sge	Jul 16.396	A3 V	AO
V524 Sgr	Jul 17.302	F8 III	F8
V766 Sgr	Jul 17.259	A6/9(e)	--
BS Sco	Jul 17.267	B5 V	F8
CT Sct	Jul 17.287	B7 V(n)	A2
VV Vul	Jul 17.366	A2/3 V	--
AX Vul	Jul 17.358	A1 V	A2
BQ Vul	Jul 16.413	AO IV	AO

the spectral types and plate information. The previous spectral type listed is usually from the GCVS. Individual comments for some of the stars follow.

AQ Cas: A detailed investigation of the spectral changes was published by Struve (1946). The current spectrum was solely that of a B3 V star with the helium lines perhaps slightly enhanced in strength. No trace of either the secondary or any emission was seen.

SZ Her: The spectrum of the primary has been stated to be variable. The plate obtained showed conflicting criteria. The spectrum is likely composite as both the G-band and λ4226 seemed suppressed, though the H and K lines were approximately equal in intensity.

CC Her: Strontium seems slightly enhanced in the spectrum of this star.

V535 Oph: The spectrum is unusual in having a typical B9 V spectrum with an unusually strong K-line of an intensity more befitting a mid-A type. This may be a function of composite nature but if so, remains the sole indication of the second star.

ELAINE M. HALBEDEL*

Corralitos Observatory
P.O. Box 16314
Las Cruces, NM 88004
U.S.A.

*Visiting Astronomer, Kitt Peak Observatory, National Optical Astronomy Observatories, operated by the Association of Universities for Research in Astronomy, Inc., which is operated under contract with the National Science Foundation.

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SPECTRAL TYPES OF ECLIPSING BINARIES IN OPTICAL COINCIDENCE WITH CLUSTERS AND ASSOCIATIONS

18 eclipsing binaries which have been listed by Sahade and Davila (1963) as being in optical coincidence with known clusters and associations were observed by the author utilizing the 2.1-m telescope and image-intensified White spectrograph of the Kitt Peak Observatory. 46 Å mm^{-1} was achieved on forming gas baked IIIa-J plates in the second order blue. All plates were of good quality. The spectrum of each system was visually classified by comparison with the MK classes of known standard stars. Table I contains the

Table I

Spectral Types

Variable	UT Date	SP. Type	Previous SP. Type	Cluster
V447 Cyg	1983 Jul 17.324	F8 Ve (comp?)	A3 + F5	NGC 6871
V586 Cyg	1982 Jun 27.406	A1 Ve	—	NGC 7039
TZ Lac	1982 Jun 28.454	F8 III (wk G)	—	NGC 7243
FP Mon	1983 Feb 2.335	F6 V (comp)	—	NGC 2353
LL Oph	1982 Jun 27.218	G5 (II/III) comp	—	Cr 302
QR Oph	1983 Jul 17.213	G8 V	—	Cr 302
V378 Oph	1983 Jul 18.244	F8 V (comp?)	—	Cr 359
V391 Oph	1983 Jul 18.260	A9 V	A1, G5	Cr 359
V441 Oph	1982 Jun 26.161	B9 III/IV	A0	Cr 302
V487 Oph	1982 Jun 28.230	F0 III	—	Cr 359
CM Per	1983 Jul 16.465	A3 V	—	Stock 2
CS Per	1983 Jul 16.481	G0 IV	—	Stock 2
HS Per	1982 Jun 29.449	A0 II/III	—	Stock 4
IM Sco	1983 Jul 17.190	G2 V	—	Cr 302
V702 Sco	1983 Jul 17.240	A0 Ve	B4	NGC 6383
BS Sct	1982 Jun 25.435	B7e	B5, A0 III, A7	M11
FN Sct	1982 Jun 25.307	B3 Ve	—	NGC 6704
BU Ser	1983 Jul 16.309	A0 V	—	IC 4756

spectral types and plate information. The previous spectral type listed is usually from the GCVS. Individual comments for some of the stars follow.

V447 Cyg: There is a single emission peak at Hβ, but no emission at Hγ. Possibly there exist faint emissions longward of Hβ. The spectrum is veiled as if composite.

TZ Lac: The G-band is visible, though suppressed for the spectral type.

FP Mon: The spectrum is thought to show composite characteristics due to the weakness of the K-line and the unnatural suppression of Hγ.

LL Oph: The entire spectrum is veiled, particularly towards the shorter wavelengths. The Balmer lines are quite weak and the CN break strong.

V 378 Oph: A possible composite spectrum is indicated by the inordinate width of the Balmer Lines, a slight veiling, and a possibly double Hδ.

V702 Sco: There exists a single emission peak in the Hβ line, but no emission elsewhere.

BS Sct: There are definite double emission fringes at λ4471 of He I, but no emission at the Balmer lines. Faint double emissions (probably of Fe II) also appear to the violet of Hγ. According to Hall and Mallama (1974), there have been conflicting classifications for the primary star: F8, A7, and A0 III. Their photometric observations during primary eclipse give a possible range for the primary of B5-A7. BS Sct is found to be a likely member of M11 as a consequence of its early spectral type and also a possible blue straggler.

FN Sct: There exists strong double emission at the He I lines and other possible emissions of Fe II. No emission is seen at the Balmer lines.

ELAINE M. HALBEDEL*

Corralitos Observatory
P.O. Box 16314
Las Cruces, NM 88004
U.S.A.

*Visiting Astronomer, Kitt Peak Observatory, National Optical Astronomy Observatories, operated by the Association of Universities for Research in Astronomy, Inc., which is operated under contract with the National Science Foundation.

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ON THE PHOTOMETRIC VARIATIONS OF HD 28843 AND HD 29009

The CP stars HD 28843 = HR 1441 (He weak) and HD 29009 = HR 1449 (B9 Si) have published photometric periods of respectively 1.37375 days (Pedersen, 1979, based on spectroscopic as well as photometric data) and 3.82 days (Renson and Manfroid, 1981).

In spite of the large amplitude of its variations, HD 28843 was not known to be variable until 1977, and we used it as a comparison star for HD 29009 in several observing runs conducted at that time. Fortunately a second comparison was included, HD 27563, and differential measurements led us to derive periods for HD 28843 and HD 29009.

Analysis of new uvby data obtained in the framework of the Long Term Observing Programme at ESO, showed that HD 27563 is also variable, with a complex behavior (Manfroid and Mathys, in preparation), displaying variations of several hundredths of a magnitude on a time scale of days.

Careful absolute reduction of all of our old data concerning HD 28843 and HD 29009, using sophisticated techniques (Manfroid and Heck, 1983) allowed to study both stars without the interference of HD 27563, and to derive new periods. Table I shows the repartition of our observations and the telescopes used. Observations of Pedersen and Thomsen (1977) were included for HD 28843.

Table I

Date	Telescope	Number of observations HD 28843	HD 29009
November 1977	La Silla Danish 50 cm	42	42
December 1978	La Silla ESO 50 cm		8
September 1981	La Silla Danish 50 cm		7
January – February 1976 (Pedersen – Thomsen)	La Silla Danish 50 cm	11	
Total		53	57

The periods derived from these data are:

HD 28843 $P = 1.37390 \pm 0.00015$ d

HD 29009 $P = 3.79864 \pm 0.00015$ d

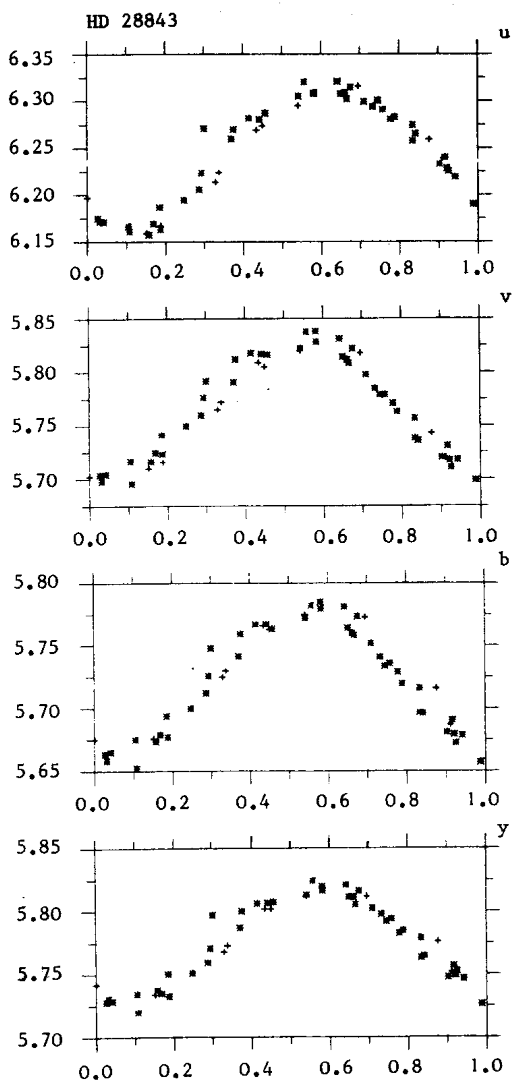

Figure 1

Phase diagrams for HD 28843 in u,v,b and y. Phase origin is JD 2442778.614 (same as in Pedersen and Thomsen, 1977). (+ Pedersen and Thomsen, January-February 1976, *November 1977)

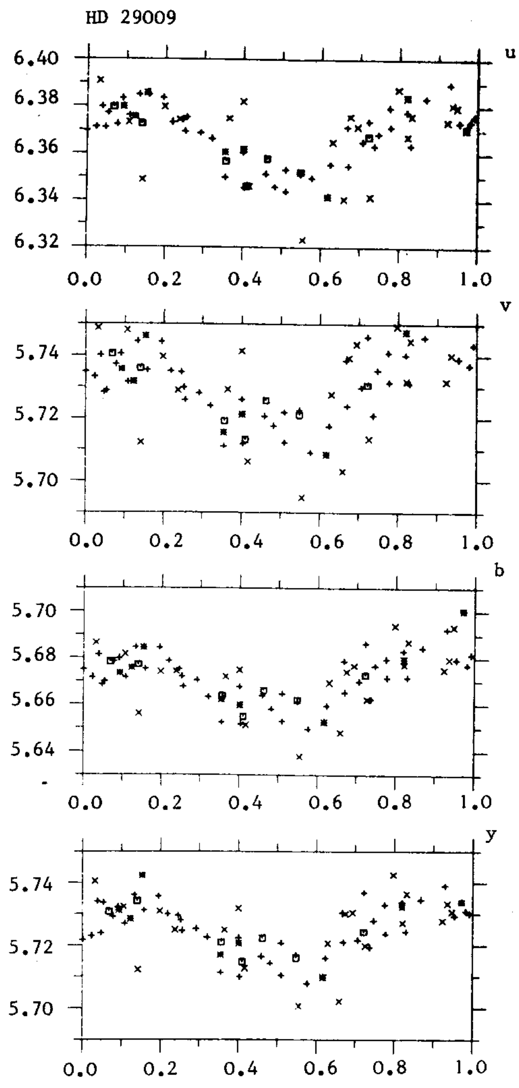

Figure 2

Phase diagrams for HD 29009 in u,v,b and y. Phase origin is JD 2443455.6421. (+November 1977, *December 1978, ⊡September 1981, xLong Term Programme) and lie within the possible ranges quoted by the previous authors. (For HD 29009, a period of about 3.84 days cannot be definitely excluded; however this value is much less likely.) The phase diagrams are presented in Figures 1 and 2.

Additional data from the ESO Long Term Photometric Programme are being obtained for HD 29009. However the variety of the equipments used so far in this programme is so large that no refinement of the period could be made. Analysis and inclusion of those data is under way however (Renson and Manfroid, in preparation). Figure 2 shows several points of good quality in 1982/83, which tend to confirm our value of the period of HD 29009.

J. MANFROID

Institut d'Astrophysique
5, avenue de Cointe
B-4200 Cointe-Ougrée
Belgium

G. MATHYS

Institut für Astronomie
ETH-Zentrum
CH-8092 Zürich
Switzerland

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PRELIMINARY ORBITAL ELEMENTS OF HD 184035

The star HD 184035 (HR 7422) was discovered by Waelkens and Rufener (1983) to be an eclipsing binary.

They also presented the V photoelectric observations and the following light elements:

$$\text{Min I} = \text{JD}_\odot\ 2444833.830 + 4^{d}.62988 \cdot E$$

HD 184035 is a konwn single lined spectroscopic binary (Buscombe, Morris 1961) with an estimated orbital period in agreeement with the photometric period. In this paper photoelectric observations are processed yielding the first set of orbital elements.

Because of the small number of observations, this solution is regarded as preliminary. For the analysis of the light curve the frequency domain approach was chosen (Kopal 1979). The solution was obtained in a completely automatized manner by relevant computer programs (Gaspani 1984), fitting both minima. My computation indicates that the primary minimum is a transit, the orbital elements are given in Table I.

Table I

Orbital elements

Min I = transit
$u_1 = 0.50$ (assumed)
$u_2 = 0.50$ (assumed)
$r_1 = 0.214 \pm 0.006$
$r_2 = 0.082 \pm 0.004$
$i = 82^\circ.6 \pm 0^\circ.8$
$L_1 = 0.898$
$L_2 = 0.102$

Since the relative radii of both components are small, a detached configuration was assumed for the system. In order to combine photometric and spectroscopic elements an estimate of the mass ratio is required. Since the spectroscopic mass ratio is unknown an estimate for $q = (m_2/m_1)$ was obtained by the ratio of the fractional luminosity and making the assumption that both components are on the main sequence (Houck 1978). The following statistical relation, fitting the main sequence data:

$$\log(m_2/m_1) \approx 0.30 \log(L_2/L_1)$$

yields $q \approx 0.52$. The combination by the mass function given by Buscombe and Morris yields the following values for masses and radii of the two components of HD 184035:

$$m_1 \approx 2.8\ M_\odot$$
$$m_2 \approx 1.5\ M_\odot$$
$$R_1 \approx 4.0\ R_\odot$$
$$R_2 \approx 1.8\ R_\odot$$

This work is regarded as preliminary because new spectroscopic and photometric observations are needed in order to carry out a more detailed analysis of this binary system.

GASPANI A.

Osservatorio Astronomico Brera-Merate
Via E. Bianchi, 46
22055 Merate (CO)
Italia

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PHOTOELECTRIC LIGHT CURVES AND PERIOD OF HD 199497

HD 199497 = BD $+19^{\circ}4574$ was first discovered to be a possible W UMa type eclipsing binary from its appearance on objective prism plates in 1966 and then observed photoelectrically by Bond (1976). He used the y filter of the Strömgren four-colour system and obtained 24 photoelectric observations. These observations showed that it was a new W UMa type eclipsing system with a range of 0.15 mag. His light elements are

$$\text{JD Hel(Min I)} = 2442687.418 + 0^{\text{d}}.3638 \cdot \text{E}$$

Photoelectric observations of HD 199497 were made with the 48 cm Cassegrain telescope of the Ege University Observatory on six nights in the summer of 1982. During the observations an unrefrigerated EMI 9781A photomultiplier tube and B,V filters close to the standard UBV system were used. A total of 199 observational points have been obtained in each colour. BD $+19^{\circ}4568$ was used as comparison and BD $+19^{\circ}4576$ as check star. No evidence for the variability of the comparison star was found.

We obtained three primary and four secondary minima. The depths of the minima are nearly equal but the mean depth of the primary minima is slightly

Table I

The times of minima

Hel.Min.JD.	Min.	Filter	O-C	Reference
2442687.418	II	y	0.000	Bond (1976)
45136.4045	II	B,V	0.0009	This paper
145.4995	II	"	0.0000	" "
146.4058	I	"	-0.0033	" "
149.5053	II	"	0.0036	" "
150.4082	I	"	-0.0031	" "
177.3357	I	"	0.0005	" "
177.5184	II	"	0.0013	" "

greater than that of the secondary. Using all the times of the minima given in Table I, the new light elements are recalculated by the method of weighted least squares as follows:

$$\text{JD Hel(Min I)} = \underset{\pm 9}{2445146.4091} + \underset{\pm 4}{0^{\text{d}}.3638368} \cdot \text{E}$$

According to the new light elements the primary minimum of Bond (1976) is a secondary minimum. The light and colour curves are presented in Figure 1 where the individual magnitude differences (variable minus comparison) have been plotted against the phases. The phases and O–C values in Table I were

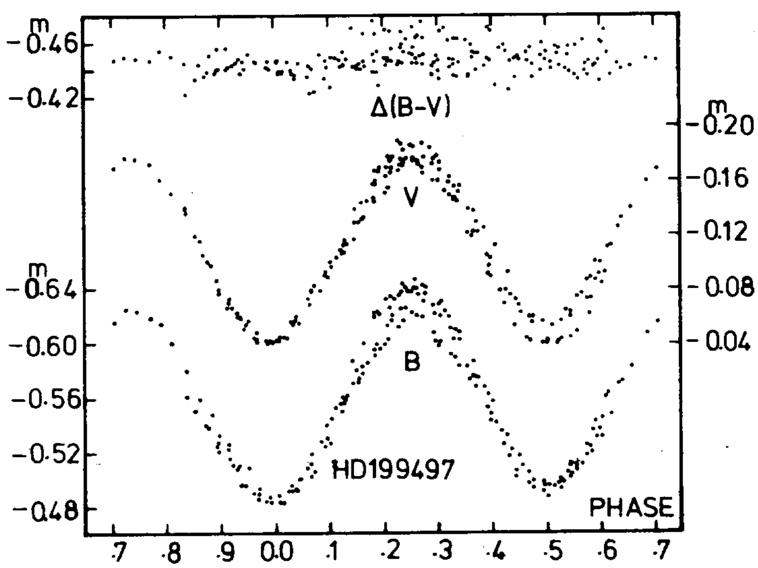

Figure 1

Light and colour curves of the HD 199497

calculated with the new elements. The light curves show that HD 199497 is a typical W UMa type eclipsing binary. The dispersions exceeding the limits of observational errors are seen on the light curves.

C. SEZER, Ö. GÜLMEN, N. GÜDÜR

Ege University Observatory
Bornova-Izmir-Turkey

Reference:

Bond, H.E., 1976, I.B.V.S. No. 1214

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THE INVESTIGATION OF THE BINARY SYSTEM TX Cas

The variability of TX Cas (BD +62°480 = HV 2895) was discovered by Leavitt (Pickering, 1907). McDiarmid (1915) first classified its light curve correctly as β Lyr - type. Though its variability is known over 70 years and the star is relatively bright, only one photoelectric minimum by Fernandez (1982) was obtained until now. Koch et al. (1979) called attention to the lack of photoelectric observations and recommended further study of the system.

For this reason the star was put on the observational program at the 0.6 m reflecting telescope of the Skalnaté Pleso Observatory. The observations were made in the standard B filter during four nights in 1982 and 1983, respectively. The comparison stars BD +62°485 and BD +62°504 were used. The only part of the light curve around primary minimum was observed. From our observations three epochs of primary minima were determined using the tracing paper method. These epochs of primary minima together with their limits of errors are presented below:

JD Hel.	E	O-C
2445233.434 ±5	5128	+0.003
2445280.271 ±10	5144	-0.010
2445593.439 ±3	5251	+0.005

The O-C values were calculated using the ephemeris given by Rätz (1983):

$$\text{Min I} = \text{JD Hel. } 2430224.512 + 2\overset{d}{.}9268563 \times E$$

It has been found that there is no significant difference from the above mentioned ephemeris. However, the lack of the accurate observations before those obtained by Fernandez (1982) and by us prevented the study of period changes.

J.M. KREINER

Institute of Physics
Silesian University
Katowice
Poland

J. TREMKO

Astronomical Institute
Slovak Academy of Sciences
Tatranská Lomnica
Czechoslovakia

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FK OPHIUCHI = V2 (NGC 6273)

The variability of FK Oph (HV 4337 = HV 9196) was first discovered by I.E. Woods (Swope, 1928). Swope found changes between $14^{m}.8$ and $15^{m}.6$ m_{pg} exhibited by this star near the globular cluster NGC 6273 (M 19). Later the star was independently discovered by Luyten (1973, 1938), with the photographic range $13^{m}.5$ - $14^{m}.5$. At first Luyten was not able to identify his star with FK Oph because of the wrong value of right ascension (by one hour) he originally determined. No information concerning the type of variability is contained in the General Catalogue of Variable Stars.

Sawyer (1943) discovered four variable stars in NGC 6273, as well as two more variables in the surrounding field. Among these variables, V2 in NGC 6273 is identical with FK Oph, as we were able to find by comparison of photographs published by Sawyer and by Swope (1932). Sawyer published 12 observations ($13^{m}.4$ - $14^{m}.7$ m_{pg}) and considered the star to be a possible long-period Cepheid. The star enters the Third Catalogue of Variable Stars in Globular Clusters (Sawyer Hogg, 1973).

I have made 42 eye-estimates of FK Ophiuchi on the plates obtained with the 40-cm astrograph of the Sternberg Institute Crimean Observatory. The observations are presented in Table I. The three observations marked with asterisks are based on photographs obtained at the same observatory with the 50-cm Maksutov camera. The system of B magnitudes is based on the photometric study of NGC 6273 by Harris, Racine and de Roux (1976). On our plates, the three brightest comparison stars from Sawyer's list are situated too deep in the dense unresolved part of the cluster and cannot be used. Five of Sawyer's comparison stars (d, f, g, h, k) were measured by Harris et al., as the brightest comparison star I used the star ZNG 5 (cf. Harris et al.).

FK Ophiuchi belongs to CW type stars. Its elements are found to be

$$\mathrm{Max} = 2445133.7 + 14^{d}.138 \cdot E,$$

$M - m = 0^{P}.35$. The Maksutov camera observations were not used for the period determination. The earlier observations published by Sawyer (1943) do not

Table I

J.D. 24...	B	J.D. 24...	B	J.D. 24...	B
37109.43	$14^{m}.21$	44015.45	$13^{m}.76$	44815.31	$14^{m}.41$
130.35	13.79	020.44	13.72	818.31	15.35
138.32	14.16	023.42	13.76	819.30	14.66
139.33	14.37	028.43	14.37	820.29	14.33
144.33	13.76	041.38	15.21	45087.52	14.53
145.33	13.59	406.38	15.15	134.41	13.52
40738.50	13.76	409.41	14.58	464.52	13.84
745.44	14.98	410.40	14.37	469.52	14.49
42922.48*	15.12	430.36	13.76	494.43	14.33
43700.36*	15.04	435.34	14.78	496.42	15.37
701.35*	15.04	438.36	14.33	496.45	15.44
989.52	13.59	789.36	15.24	499.41	14.25
992.52	13.79	811.32	13.76	523.38	14.49
993.45	13.79	812.31	13.64	546.32	13.67
994.55	13.81	813.31	13.79	552.3	14.78:

contradict our elements, and their limited number does not give a possibility to improve the elements. The light curve is shown in Figure 1.

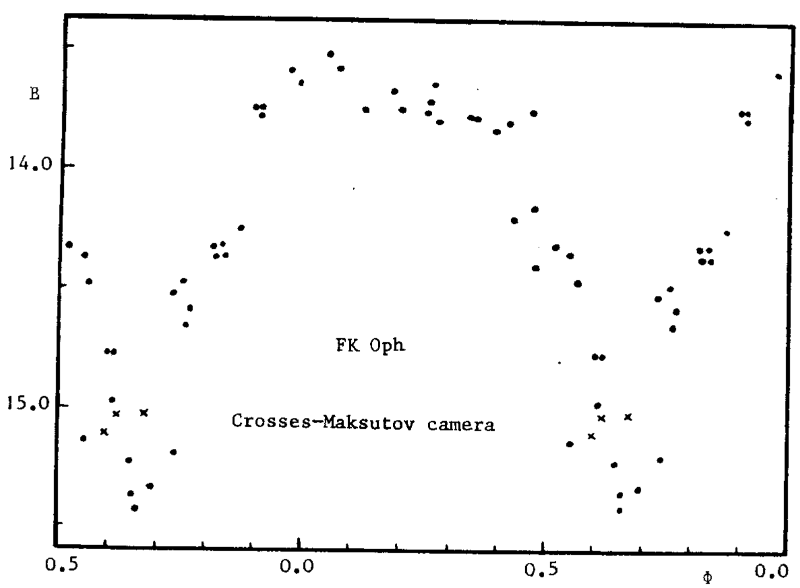

Figure 1

It is worth noting that FK Oph is the star No. 509 ($V = 13^{m}.40$, $B-V=0^{m}.78$) in the M 19 photometric catalogue by Harris et al. (1976). Their values are compatible with possible cluster membership of this Cepheid.

I am grateful to Prof. P.N. Kholopov for the possibility to use his computer program for period determination.

N.N. SAMUS'

Astronomical Council of the
USSR Academy of Sciences
48, Pyatnitskaya Str.
Moscow 109017, USSR

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PHOTOGRAPHIC OBSERVATIONS OF AT Cnc IN 1983/84

Photographic observations of AT Cnc were carried out in November, 1983 through March, 1984, with 18-cm Schmidt camera in two colours. 103a-O emulsion with sharp cut filter at 3900A, and Tri-X emulsion with yellow-green filter were used for photographic and visual magnitudes, respectively. The photographic magnitudes of comparison stars by Götz (1983) were used, and their visual magnitudes were determined by the author. The results are shown

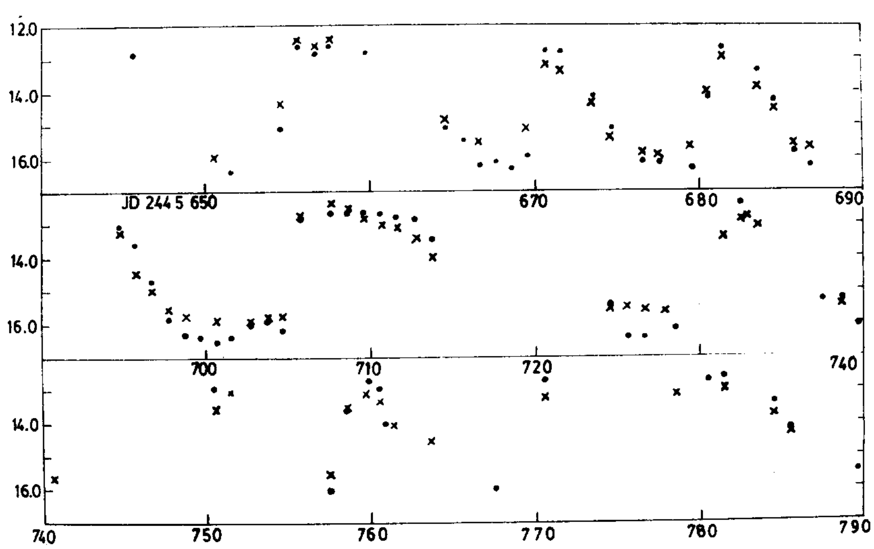

Figure 1

in Figure 1, in which photographic magnitudes are by dots and visual magnitudes by crosses.

The light curve shows fairly regular variation with the period of $12\overset{d}{.}5$. The amplitudes are $12\overset{m}{.}5$-$16\overset{m}{.}0$ (visual) and $12\overset{m}{.}5$-$16\overset{m}{.}5$ (photographic). I like to point out that the light curve is very much similar to that of the dwarf nova and X-ray emitting star, HL CMa, in their amplitude, period and the behavior of variation, having broad and narrow maxima irregularly.

M. HURUHATA

Hodozawa 88,
Gotemba-shi,
412 Japan

Reference:

Götz, W., 1983, I.B.V.S. No. 2363

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FLARE ACTIVITY OF HD 282773 (G5)

HD 282773 (reference star) and HD 282633 (check star) were used as comparison stars in observations of SU Aur over the period from 1981 to 1982. The magnitude differences of these stars have been obtained using a 20" reflector with UBVR counting photometer during 28 nights on the Peak Terskol. The average standard deviations of individual UBVR differences are:

$$\sigma_U = 0\overset{m}{.}026, \qquad \sigma_B = 0\overset{m}{.}018, \qquad \sigma_V = 0\overset{m}{.}017, \qquad \sigma_R = 0\overset{m}{.}016.$$

During the 2-year period of observations the stars seemed to be fairly constant, but continuous photoelectric monitoring of HD 282773 on 10 October 1981 revealed a flare similar to those of UV Ceti variables. Figure 1 shows

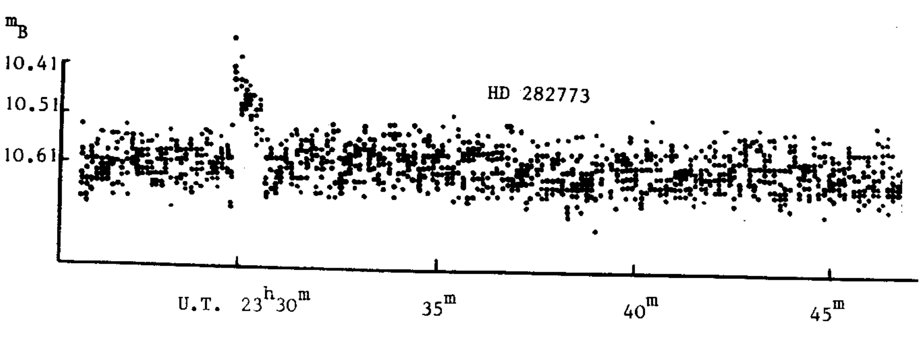

Figure 1

the light curve obtained during 20-minute monitoring in B filter. The integration time was $1\overset{s}{.}0$. The amplitude of the flare was $0\overset{m}{.}25$, the duration was about 1 minute.

On the following night additional observations were made with the same technique but no noticeable variability was recorded.

Since this star belongs to the G5 spectral class the energy parameter of the observed flare is of great interest. In accordance with our measurements the V magnitude and colours of the variable are:

$$V = 9\overset{m}{.}723 \pm 0\overset{m}{.}006,$$
$$B - V = 0\overset{m}{.}887 \pm 0\overset{m}{.}009,$$
$$U - B = 0\overset{m}{.}557 \pm 0\overset{m}{.}010,$$
$$V - R = 0\overset{m}{.}724 \pm 0\overset{m}{.}008.$$

The known spectral class and colour-indices make it approximately possible to establish a luminosity class and to estimate the flare energy. The colour excess of HD 282773 is between $E_{B-V} = 0\overset{m}{.}13$ (if the star is a giant) and $E_{B-V} = 0\overset{m}{.}25$ (if the star is a dwarf). The self-consistent solution of the equation

$$m - M = 5 \lg r - 5 + 3.2\ E_{B-V}$$

gives:

$$M_V = 3\overset{m}{.}1, \qquad E_{B-V} = 0\overset{m}{.}19, \qquad r = 158\ \text{pc}$$

The obtained distance r and colour-excess E_{B-V} well agree with the interstellar extinction in the direction of the star (Neckel, 1967).

The energy distribution in the spectrum of the star has been assumed to be a black-body with a temperature $T_e = 5300$ K. Thus, we can estimate a part of energy α_B radiated by the star in the B-band of our photometric system:

$$\alpha_B = \frac{\int_0^\infty F_\lambda \cdot T_\lambda \cdot d\lambda}{\int_0^\infty F_\lambda \cdot d\lambda}$$

where: F_λ is the Planck's function,

T_λ is the relative response function of the B bandpass.

In this case, $\alpha_B = 0.075$.

As the absolute magnitude is $M_V = 3\overset{m}{.}1$, the total luminosity of the star is

$$L_* = 4.9 L_\odot = 1.9 \cdot 10^{34}\ \text{erg sec}^{-1}.$$

Hence, the energy radiated by the star in the B band is equal to

$$L_B = 1.4 \cdot 10^{33}\ \text{erg sec}^{-1}.$$

and the energy of the flare shown in Figure 1 is:

$$E_B = 7.6 \cdot 10^{33}\ \text{ergs}.$$

Then the total optical energy of the flare is estimated as:

$$E_{opt.} \geq 10^{34}\ \text{ergs}.$$

Neither possible error in M_V nor 10% - 20% additional energy from emission lines (Moffet, Bopp, 1976) can essentially decrease the order of the value $E_{opt.}$. Hence the recorded flare is one of the most powerful in the flare stars.

If the flare activity of the HD 282773 obeys the statistical relationship between frequency and energy of individual flares (Gershberg, 1978), the star must show flares with smaller amplitudes, the mean frequency of flares increasing with the decrease of their energy. From that it follows that small optical flares ($0^m.01$ - $0^m.001$) could be a cause of the potential microvariability of the star.

KOVALCHUK G.U. and PUGACH A.F.

Main Astronomical Observatory
Ukrainian Academy of Sciences,
Kiev, USSR

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ELECTROPHOTOMETRY OF DH Peg AND AV Peg

Electrophotometry of selected RR Lyrae stars in intermediate band Strömgren system and H_β is in progress at Abastumani Astrophysical Observatory, after a new automatic 125 cm reflector was put into operation in 1980. The final aim of the present investigation is to determine the physical parameters of stellar atmospheres and the metallicity index. The filters used for presentation of the above system were kindly contributed for temporary use by Dr. R.M. West. These filters, belonging to the European Southern Observatory, are used for observing Ap stars in collaboration with Dr. R.M. West. The stars are being observed with the same telescope according to the programme coordinated by Dr. R.M. West.

The photometry of the variables was fulfilled automatically. BD +5°4982 (for DH Peg) and BD +21°4636 (for AV Peg) served as the comparison stars. Table I lists the photometric characteristics determined by the recent observations.

Table I

Star	V	b-y	m_1	c_1		n
+ 5°4982	8.41	0.055	0.107	0.835	2.800	12
	03	009	020	013	014	
+21°4631	9.48	0.564	0.300	0.430	2.570	13
	02	008	019	031	018	

The last column shows the number of determinations. The rms errors of one determination of each value are given too.

The photometric results of DH Peg and AV Peg are shown in Figures 1 and 2. The extreme values of the observed parameters are given in Table II.

Table II

Parameter	DH Peg			AV Peg		
	Max		Min	Max		Min
V	9.27		9.74	10.02		10.92
b-y	0.164		0.355	0.130		0.346
m_1		<0.094>			<0.147>	
C_1	1.276		1.012	1.310		0.696
H_β	2.828		2.682	2.822		2.655

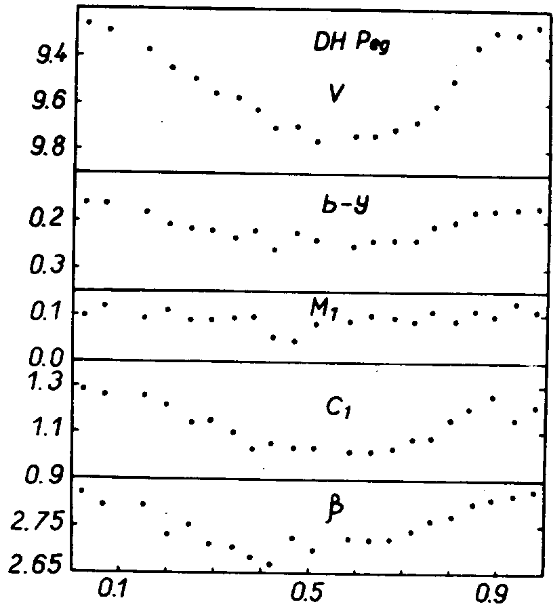

Figure 1

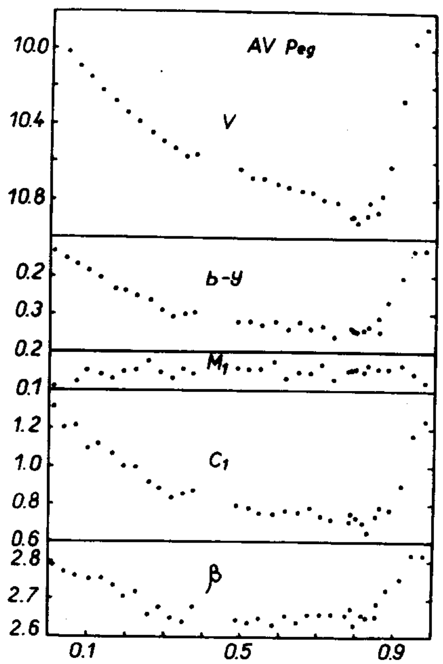

Figure 2

The complete data on the above-mentioned stars and the discussion will be published later. We should like to report that data have also been obtained and processed for the stars RR Lyr, RZ Cep, TT Lyn, SZ Lyn, XZ Dra, BH Peg, TU UMa.

I. Ph. ALANIA

Abastumani Astrophysical
Observatory, Academy of
Sciences of the Georgian SSR
U.S.S.R.

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UNE AUTRE ÉTOILE Ap À ÉCLIPSES ?

Dans un bulletin récent (Renson et Mathys 1984), des indications ont été données concernant trois étoiles Ap qui présentent des éclipses. L'intérêt de telles étoiles est que l'étude des changements de leurs spectres durant les éclipses partielles pourrait mettre en évidence les inhomogénéités de composition de leurs atmosphères, qui ont été postulées notamment dans le cadre du modèle du rotateur.

Or une autre étoile à éclipses appartient peut-être aussi à la catégorie des Ap : BD+4°2748 = AX Vir. Elle est en effet renseignée comme Ap par Klemola (1962), dont c'est le numéro 174. Notons toutefois que le spectre n'avait pas été trouvé anormal par Cowley (1958) : n°59 de sa table II. Il est à souhaiter qu'il n'y ait pas d'erreur d'identification de la part de Klemola, qui donne pour cette étoile des coordonnées légèrement erronées; les véritables coordonnées pour l'époque 1900 sont en effet $\alpha=13^h22^m\!,7$ et $\delta=+4°24'$. A la suite de la publication du travail de cet auteur, Bertaud a introduit cette étoile, sous le numéro 745, dans le deuxième supplément de son catalogue (1965), en reproduisant d'ailleurs telles quelles les coordonnées erronées que donnait Klemola.

De toute façon, cette étoile est malheureusement de magnitude encore plus élevée que les moins lumineuses de celles qui sont considérées dans le Bulletin n°2522. Sa magnitude est en effet 10,3 en dehors des éclipses.

La profondeur du minimum principal atteint 0,6 mag, tandis que celle du minimum secondaire est à peine 0,2 mag. La période est courte : 0,702527j, d'après les observations de Jensch (1935), qui avait appelé cette étoile 17.1935 Vir, Lause (1937) et Whitney (1955). Cela entraîne que les éclipses partielles sont très brèves, ce qui augmente l'inconvénient de la magnitude élevée. Des observations valables ne peuvent donc être envisagées qu'avec des instruments très performants.

La position de cette étoile est : $\alpha=13^h25^m{,}2$ et $\delta=+4°08'$ pour l'époque 1950. Son type spectral est environ A2. Mais le type d'anomalie n'est pas défini, car Klemola (1962) signale seulement en note "λ4481 and λ4030 are seen". Une meilleure étude spectrographique est donc souhaitée.

P. RENSON

Institut d'Astrophysique
de l'Université de Liège
5, avenue de Cointe
B-4200 Ougrée (Belgique)

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AMPLITUDE-WAVELENGHT DEPENDENCE FOR W UMa-SYSTEMS

It is well known that the amplitude of light change of a W UMa type system in blue region is larger than in yellow. Indeed, the first IR-observations of these systems (Jameson and Akinci, 1979) confirmed the existence of this regularity up to λ = 2.2 μm. The dependence of the amplitude difference $(A_V - A_\lambda)$ on λ is shown in Figure 1. IR-data for this figure are given in Table I. Our observations of V 523 Cas were used for the optical range. In

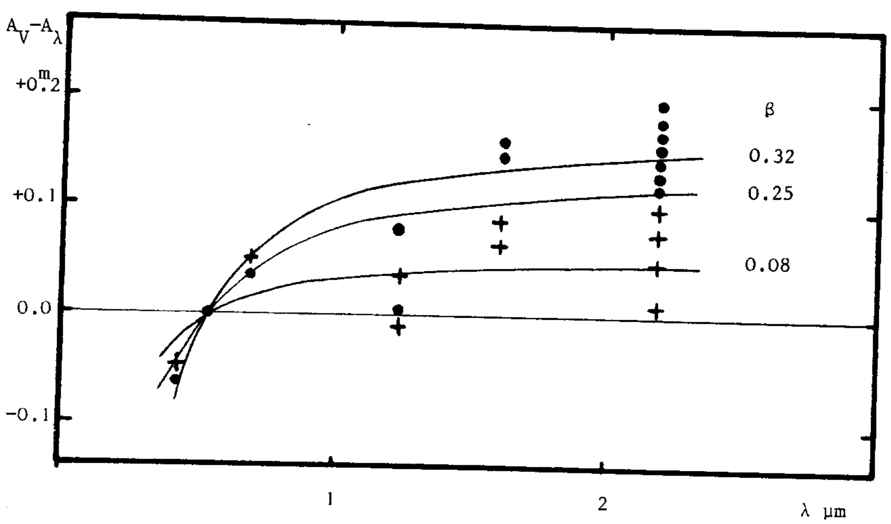

Figure 1

The observed dependence of the difference of the amplitudes $(A_V - A_\lambda)$ on λ for the W-systems (min 1 is shown by dots, min 2 - by crosses). The theoretical curves (solid lines) for systems of spectral type KOV, filled up their Roche lobes, are shown for three values of β.

spite of the scattering of points a general character of the dependence may be revealed by the diagram: a sharp decrease of the difference of amplitude in the range up to 1 μm and more smooth change of the $(A_V - A_\lambda)$-value at λ > 1 μm. The observations of W UMa by Philips et al. (1980) give larger

Table I

System	Min	A_V	A_H	A_K	A_V-A_H	A_V-A_K	IR-data from:
W UMa	1	$0^m.73$	$0^m.43$	$0^m.43$	$0^m.25$	$0^m.25$	Philips et al. (1980)
	2	0.64					
	1	0.73	0.59	-	0.14	-	Shenavrin and
	2	0.64	0.55	-	0.09	-	Zhukov (1984)
AB And	1	0.82	-	0.68	-	0.14	Jameson and
	2	0.67	-	0.66	-	0.01	Akinci (1979)
SW Lac	1	0.78	-	0.66	-	0.12	"
	2	0.72	-	0.63	-	0.08	
VW Cep*	1	0.48	0.32	0.33	0.16	0.15	Shenavrin and
	2	0.38	0.31	-	0.07	-	Zhukov (1984)
	1,2	-	-	0.28	-	0.20	Lunel et al. (1982)
44i Boo*	1	0.61	-	0.47	-	0.14	Jameson and
	2	0.49	-	0.44	-	0.05	Akinci (1979)
	1	0.61	-	0.41	-	0.20	Bergeat et al. (1981)
	2	0.49	-	0.39	-	0.10	

* - the third light is taken into account

values of (A_V-A_λ) for W UMa in comparison with other systems. The reason of this may be explained by using the optical observations made non-simultaneously with IR ones and by a comparatively low precision of early IR-observations. In any case, our observations of W UMa in H-band do not show such deviation (Shenavrin and Zhukov, 1984). Zhukov and Chruzina (1983) computed theoretical light curves for W UMa-systems permitting to obtain the theoretical dependence (A_V-A_λ) which is shown in Figure 1 by solid lines (due to special features of the computer this dependence is suitable for interpretation of data only for primary minima of W-systems). As it is seen from Figure 1, theoretical dependence satisfactorily imitates the observations assuming that primaries fill up their Roche lobes and the gravitation darkening coefficient is $\beta \geq 0.25$. $(A_V-A_\lambda)_2$ -dependence for secondary minima has a less steep slope. It is well seen from Figure 2 which represents the dependence of (A_1-A_2) amplitude difference on λ in primary and secondary minima.

Different behaviour of the dependences (A_V-A_λ) for min 1 and min 2 in infrared range can be explained by different temperatures of the components. But in this case, the observed dependence $(A_V-A_\lambda)_2$ must have quite different behaviour even if ΔT = 100-200 K. Our calculations show that the dependence (A_V-A_λ) becomes weaker if the components do not fill up their Roche lobes. Thus the different degree of the accretion of the lobes of the components may be a cause of the decrease of (A_1-A_2)-value in the IR-range. The last suggestion, however, needs further confirmation.

The difference in the depths of minima which reaches maximum value in optical range again decreases in UV-range (UV light curves of W UMa by Eaton

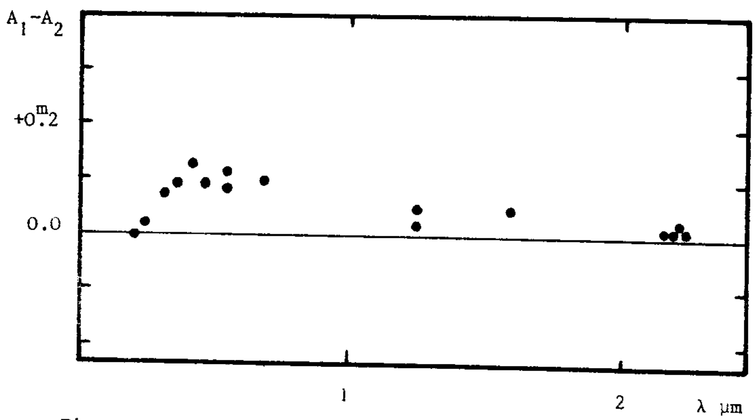

Figure 2. The observed dependence of the amplitude difference in primary and secondary minima (A_1-A_2) on λ.

et al. (1980) were used by us). One can explain this neither by different temperatures nor different geometry of the components. However, if UV-excess in some W UMa-systems will be related mainly to the inner atmosphere of primary, one can try to explain the observed decrease of the amplitude differences of minima in UV-range with an eclipse of regions, causing this excess (it happens in secondary minima).

Conclusions

1. In all investigated systems (W-type only) the amplitude of the light change decreases with the increase of λ.

2. This dependence (A_V-A_λ) essentially differs for primary and for secondary minima.

3. The observed dependence (A_V-A_λ) as a whole can be explained with different geometry of the components, assumed $\beta \geq 0.25$ in addition. With $\beta = 0.08$ the necessity appears to include some additional factor which decreases the amplitude of the variability of W UMa-stars in IR-region. Accurate observations at $\lambda > 2$ μm are needed to resolve this problem. Then the cause of IR-excess in W UMa-systems would be clear.

4. The magnetic activity of W-system's primaries which is connected with a considerable UV-excess is a probable reason of (A_1-A_2)-value decrease in UV-range.

G.V. ZHUKOV

Kazan University
Department of Astronomy
Kazan, U.S.S.R.

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AUTOMATIC PHOTOELECTRIC TELESCOPE: FIRST QUARTER 1984 OBSERVATIONS

The Automatic Photoelectric Telescope at Fairborn Observatory West in Phoenix, Arizona began its second quarter of operation on the night of 1 January 1984. Photometry from this date through the end of March 1984 included a program of 71 groups of stars, with each group consisting of a variable, a comparison star, a check star, and a sky position. During this time 3017 group observations were made. Since each group observation consisted of a sequence of 33 different 10-second observations, there was a total of 99561 observations.

The individual differential magnitudes have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars, where they are available (Breger, 1982) as File No. 136, which contains four parts. Part I is a summary of the contents of the file. Part II is a summary listing of the names of the 71 groups observed. Part III is a listing of detailed information on the 71 groups of stars observed. Part IV contains the actual observational results. Data on specific variables can be requested, if the entire contents of the file are not needed.

Table I lists the 71 groups in the program. The first column is the group number. The second is the group name. And the last is the number of pages of reduced data in File No. 136. No data were obtained for six of the groups, which were below the horizon.

The sequence of UBV observations within a group, the extinction and transformation coefficients used in the reduction, and other particulars on the acquisition, reduction, and presentation of the data have been given by Boyd, Genet, and Hall (1984).

An automatic photoelectric telescope produces a large amount of data, all of which we do not expect to utilize fully. Therefore we plan to deposit our data from the automatic telescope in the I.A.U. Commission 27 Archive expeditiously and invite other investigators to make good use of

Table I

The 71 Groups on the First-Quarter 1984 Observing Program

no.	name	obsv.	pages	no.	name	obsv.	pages
1	lambda And	20	1	36	II Peg	0	0
2	39 AY Cet	13	1	37	TZ Tri	28	1
3	sigma Gem	91	3	38	53 xi UMa (B)	122	4
4	V711 Tau	45	2	39	BH CVn	99	3
5	27 & 28 LMi	125	4	40	HD 26337	35	1
6	HR 9024	25	1	41	HD 8357	19	1
7	HR 7428	8	1	42	HR 454	47	2
8	IM Peg	7	1	43	HR 1362	45	2
9	HR 7275	13	1	44	HD 37824	57	2
10	HR 6469	72	2	45	HR 3337	85	3
11	DK Dra	43	2	46	HD 116204	71	2
12	R Sct	0	0	47	theta CrB	83	3
13	12 BM Cam	47	2	48	iota Peg	5	1
14	33 Psc	4	1	49	HD 217188	0	0
15	5 Cet	3	1	50	HD 219989	15	1
16	UX Ari	51	2	51	beta Lyr	19	2
17	59 d Ser	8	1	52	V367 Cyg	0	0
18	FS Com	98	3	53	zeta Aur	42	2
19	HK Lac	6	1	54	31 Cyg	0	0
20	AR Lac	2	1	55	32 Cyg	0	0
21	29 Dra	9	1	56	HD 25893	61	2
22	54 Cam	90	3	57	HD 28591	65	2
23	51 & 52 Aur	76	3	58	HD 136901	47	2
24	CE Tau	52	2	59	HD 9312	36	1
25	TV Psc	16	1	60	HR 503	35	1
26	RZ Ari	43	2	61	3 Cam	80	3
27	rho Per	69	2	62	HR 1970	41	2
28	IN Hya	45	2	63	1 Gem	57	2
29	epsilon Aur	63	2	64	HR 4430	100	3
30	zeta And	30	1	65	HR 6950	24	1
31	13 Cet	9	1	66	HR 7260	16	1
32	TZ CrB	30	1	67	81 Psc	16	1
33	omicron Dra	17	1	68	11 Hya	85	3
34	V350 Lac	3	1	69	31 Com	103	3
35	93 Leo	132	4	70	37 Com	88	3
				71	HR 1023	26	1

it in their own research. We ask only that the source of the data be referenced properly in any paper which results.

LOUIS J. BOYD
Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET
Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL
Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

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Boyd, L. J., Genet, R. M., and Hall, D. S. 1984, I.B.V.S. No. 2511.

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A PHOTOMETRIC ANOMALY AROUND THIRD CONTACT IN EPSILON AURIGAE

Beginning on the night of JD 2445646, the Automatic Photoelectric Telescope at Fairborn Observatory West in Phoenix, Arizona began observing the long-period eclipsing binary epsilon Aurigae. Although these observations are continuing, this paper provides results through JD 2445785. During this time, 144 group observations were made on 79 different nights, while observations were not made on 60 nights, primarily due to poor weather. Each group observation consisted of 33 different 10-second observations in three bandpasses of the variable, comparison star, check star, and sky. The total telescope time devoted to this variable was about 19.7 hours, while the total time spent actually integrating starlight was about 13.2 hours. Thus we see that roughly one third of the telescope time is needed to move the telescope, acquire the stars, and change the filters. Often 3 or 4 group observations were made on the clear nights prior to JD 2445700, but there were some six gaps in the observations due to extended cloudy weather. After JD 2445700 there were fewer group observations per night, because the telescope's observing program had been expanded from 29 to 71 different groups, but this was compensated for somewhat by the greater percentage of clear nights.

Individual magnitudes, including differential check minus comparison magnitudes, are available from the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1982). File No. 131 contains the observations prior to JD 2445700, while file No. 136 contains the remainder. The comparison star used for all observations was HD 32655, while the check star was HD 31964. The difference between the comparison star and the check star remained sufficiently constant during the period of observation to inspire confidence in the photometry.

The operation of the Automatic Photoelectric Telescope and the reduction of the data have been discussed by Boyd, Genet, and Hall (1984 ab). The data have been corrected for differential extinction and transformed to the standard UBV system.

In the light curves in Figure 1 each point is an average of three separate differential magnitudes taken one after another. There it can be

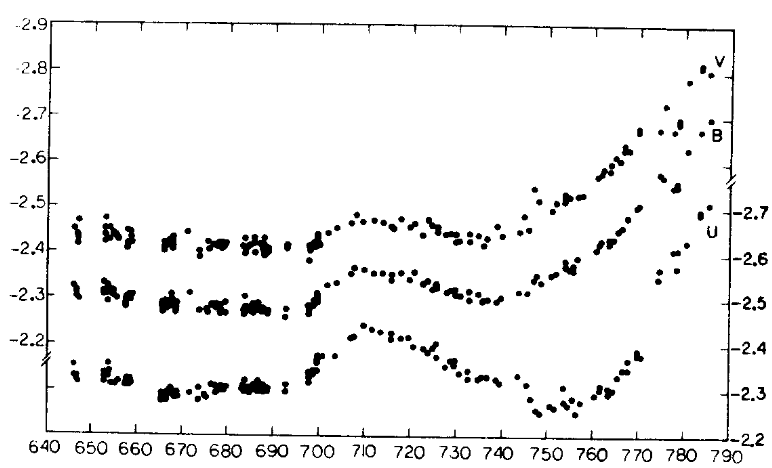

Figure 1

Observations of epsilon Aurigae made by the Automatic Photoelectric Telescope before, during, and after third contact. The ordinate is differential magnitude in the sense variable minus comparison and the abscissa is the last three digits of the Julian date. An anomalous brightening, most pronounced and persistent in the U, began around JD 2445695.

seen that an anomalous brightening began about JD 2445695 and peaked about 15 days later. This peak was most pronounced in the U, as was the 40-day decline of $0^{m}.18$. Recovery from the decline started first in the V and was followed shortly by a recovery in B, but there was a pronounced delay of almost 25 days before the recovery began in U. While the anomaly began with a decided color shift towards the blue, it ended with a definite shift to the red. This color reversal and its occurrence so near third contact may help interpret the enigma that is epsilon Aurigae.

The beginning of this anomaly has been independently observed and previously reported by Oki, Sekiya, and Hirayama (1984). We wish to thank Robert E. Stencel for first bringing this anomaly to our attention.

LOUIS J. BOYD
Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET
Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL
Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

References:

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1983-1984 PHOTOMETRY OF THREE SEMI-REGULAR VARIABLES

The Automatic Photoelectric Telescope at Fairborn Observatory West in Phoenix, Arizona has been used to obtain UBV photometry of six semi-regular variables on the AAVSO Photoelectric Photometry Program. In this paper we present V-band results for the three with the most complete coverage.

The Automatic Photoelectric Telescope used to make the observations has been described by Boyd, Genet, and Hall (1984a). The complete set of data in all three bandpasses of the UBV system has been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1982) where it is available as File No. 131 (1983) and File No. 136 (1984).

Shown in Figures 1, 2, and 3 are the V-band light curves for rho Per, CE Tau, and FS Com, respectively. The data were corrected for differential extinction and transformed differentially to the standard UBV system. The coefficients used in the reduction procedure have been given by Boyd, Genet, and Hall (1984b). The ordinates are the differential magnitudes between the variable and comparison stars, while the abscissas are the Julian dates (plus 2445000). The comparison and check stars observed are shown in Table I. The differential magnitudes between the comparison and check stars were found not to vary significantly.

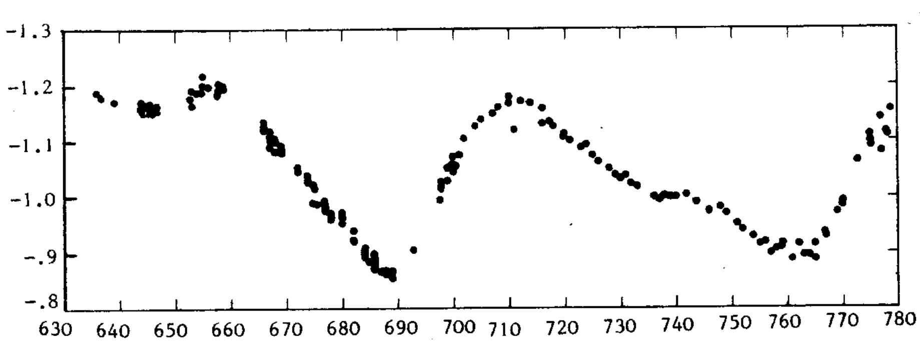

Figure 1

1983-1984 photoelectric light curve of rho Persei in V

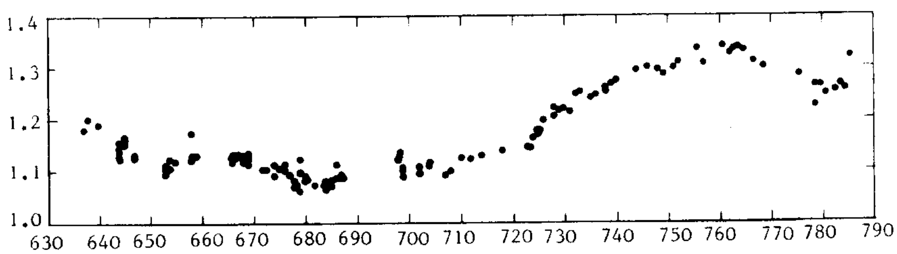

Figure 2

1983-1984 photoelectric light curve of CE Tauri in V

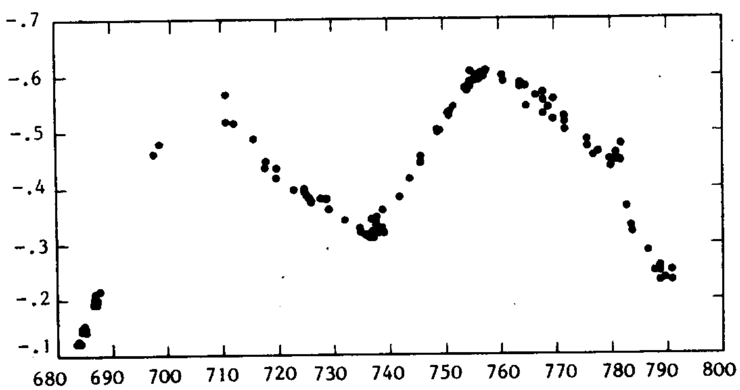

Figure 3

1983-1984 photoelectric light curve of FS Comae in V

Table I

Variable, Comparison, and Check Stars

Variable	Comparison	Check
rho Per = HD 19058	HD 19656	HD 18339
CE Tau = HD 36389	HD 35802	HD 35296
FS Com = HD 113866	HD 113848	HD 114724

We wish to thank John R. Percy at the David Dunlap Observatory for providing detailed information on the variable, comparison, and check stars. We also wish to thank Michael M. Genet for plotting the light curves.

LOUIS J. BOYD
Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET
Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL
Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

References:

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PERIOD VARIATIONS OF SS Ari

SS Ari (BD +23°279) is an eclipsing binary of W UMa-type. The new photoelectric observations of this system were carried out in October, 1982. A single channel photometer attached to the 60 cm reflector of the Ostrowik Station of the Warsaw University Observatory was used. Based on our observations we calculated three individual times of minima. They were determined with the method of Kwee and Van Woerden (1956) and are given below:

JD Hel	σ		Colour
2445261.3843	0.0002	Min II	V
.3856	0.0005		B
2445261.5859	0.0002	Min I	V
.5861	0.0004		B
2445262.3992	0.0003	Min I	V
.3982	0.0003		B

Figure 1 shows the O-C diagram. It is based on the data available in literature.

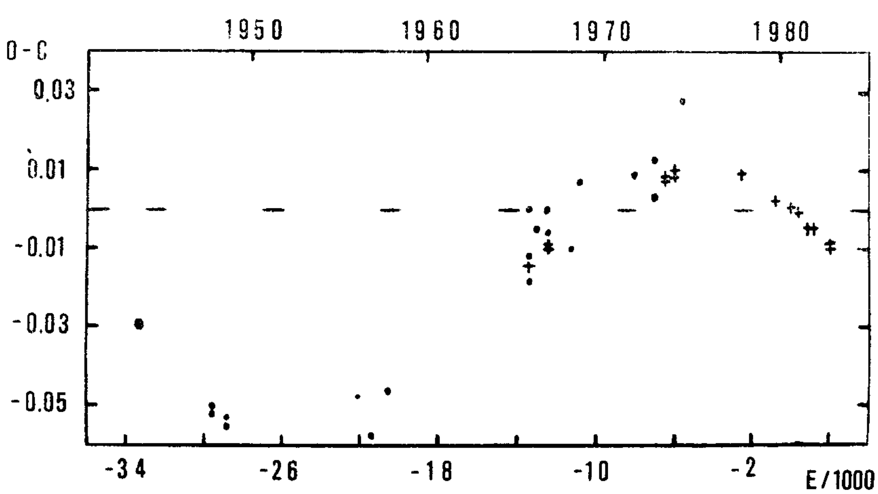

Figure 1

The crosses denote photoelectric times of minima, the dots visual or photographic ones. The minimum at E = -33 304 is a mean value from 12 visual minima. The O-C deviations were calculated using the ephemeris:

$$\text{HJD Min I} = 2444469.5060 + 0\overset{d}{.}40599174\ E$$

One can see that the O-C diagram has a sine-like shape. This suggests a presence of a third body in the system. However basing on the available data we cannot rule out a possibility that the period variations of SS Ari are not continuous. The abrupt character of changes of the period is typical for most W UMa-type systems.

Future determinations of the times of minima of SS Ari would be useful. The detailed analysis of the light curves of SS Ari will be published in Acta Astronomica.

J. KAŁUZNY and G. POJMAŃSKI

Warsaw University Observatory
Al. Ujazdowskie 4
00-478 Warszawa,
POLAND

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NEW NON-STABLE STARS IN ORION

Continuing photographic survey with the help of the wide-field 70/100/210-cm Meniscus-type telescope of the Abastumani Astrophysical Observatory in 1982-1984 8 new flare stars (Table I) and 9 repeated flares (Table II)

Table I

No	RA(1900)	D(1900)	m_{pg}	Δm_{pg}	Date
132	$5^h30^m30^s$	$-4^\circ15'.9$	$17^m.4$	$1^m.5$	17.11.1979
133	5 31 17	-6 14.2	16.3	1.1	26.10.1981
134	5 27 49	-3 47.0	17.3	1.8	11.12.1982
135	5 22 46	-4 10.3	18.7	2.4	18.12.1982
136	5 30 19	-5 34.8	15.9	1.0	19.01.1983
137	5 36 13	-5 45.3	17.5	1.0	02.02.1983
138	5 29 51	-4 27.1	18.2	2.2	08.02.1983
139	5 30 50	-4 30.0	16.9	0.8	09.02.1983
140	5 30 26	-4 21.1	16.8	1.1	09.02.1983
141	5 33 18	-6 45.2	20.1	4.2	11.02.1983

Table II

No	RA(1900)	D(1900)	m_{pg}	Δm_{pg}	Date	Ident.
1	$5^h26^m27^s$	$-4^\circ41'.5$	$16^m.7$	$4^m.3$	12.12.1982	A 59
2	5 33 03	-6 28.2	14.6	1.2	12.12.1982	B 22
3	5 28 15	-5 03.3	17.7	1.1	17.12.1982	T 13
4	5 28 17	-4 55.8	17.2	1.3	24.12.1982	Ab 43
5	5 29 06	-6 40.3	18.2	2.7	03.02.1983	T 177
6	5 34 54	-6 28.1	16.5	1.2	09.02.1983	T 173
7	5 29 51	-5 01.7	18.0	1.4	09.02.1983	T 149
8	5 25 09	-4 27.6	17.4	1.0	11.02.1983	T 124
9	5 31 32	-7 19.8	19.3	4.1	20.03.1984	Ab 102

around Orion Trapezium have been found. In order to detect variable stars in the same field the whole accumulated material of 1978-1984 has been reexamined and 2 new flare stars and 28 variables (Table III), which have not been known as variables, were found. For these variables it is impossible to tell the type of variability, but according to their behaviour they all are probably RW Aurigae-type stars. They may not have shown variability for some time, and probably they had not shown it at all, and entered into activity phase not long ago. This can be especially said in the case of star No. 24, which is

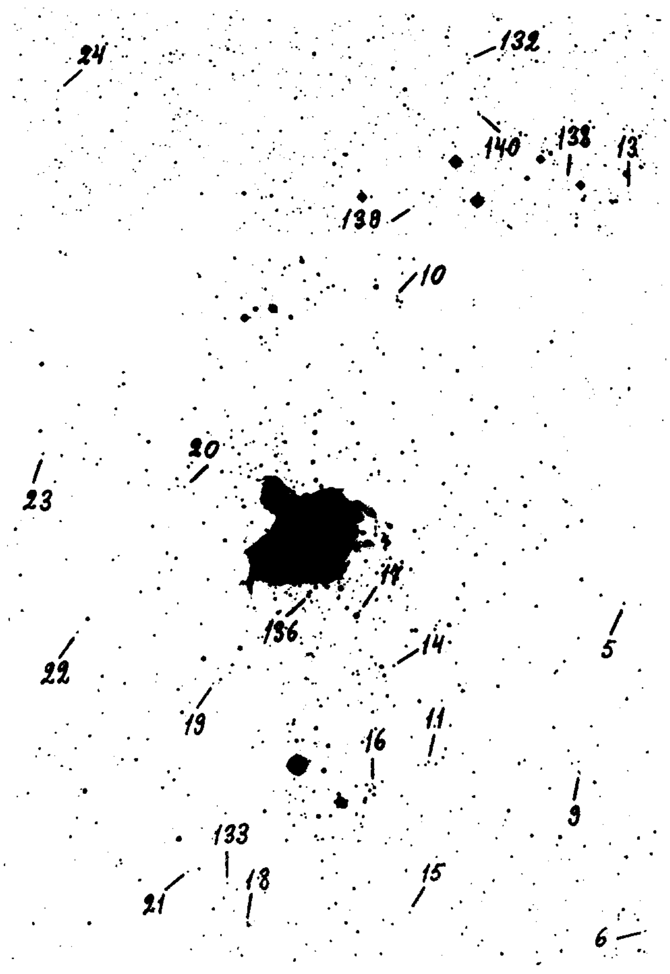

Figure 1

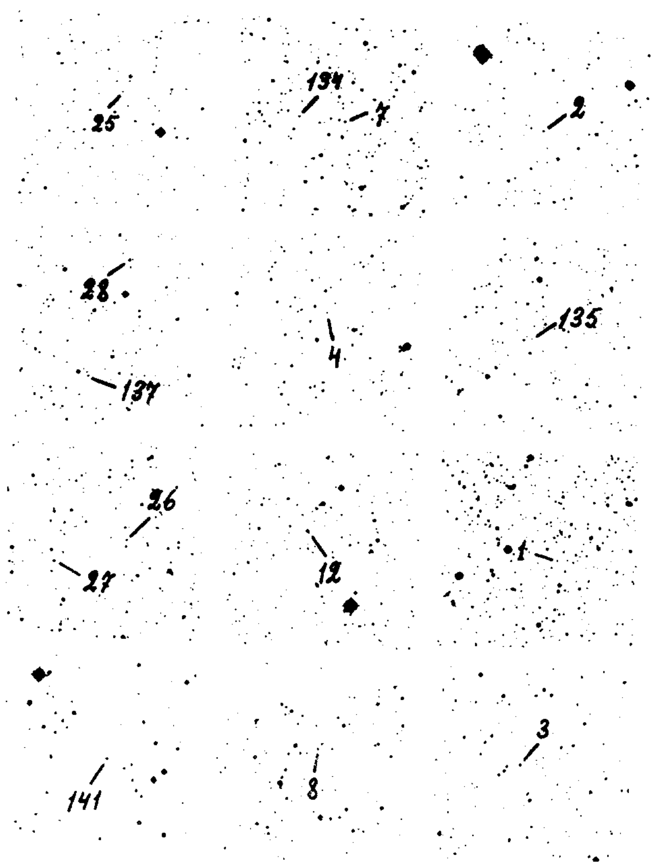

Figure 2

Table III

No	RA(1900)	D(1900)	m_{min}	Δm	Date
1	$5^h22^m20^s$	$-5^o21!5$	$17^m.8$pg	$2^m.3$pg	12.12.1982, 11.10.1981
2	5 24 01	-3 38.7	16.0pg	3.5pg	02.02.1983, 20.03.1984
3	5 24 44	-6 34.1	18.0pg	1.4pg	11.10.1978, 28.01.1979
4	5 26 38	-6 13.1	17.2U	1.2U	25.02.1982, 29.01.1981
5	5 27 21	-5 39.3	17.4pg	0.9pg	11.12.1982, 28.10.1979
6	5 27 22	-6 25.2	17.1pg	1.2pg	27.11.1978, 02.02.1983
7	5 27 27	-3 47.5	16.4pg	1.1pg	18.12.1982, 08.02.1983
8	5 27 45	-7 38.7	17.5B	1.2B	14.12.1982, 12.12.1982
9	5 27 53	-6 02.3	18.3B	0.8B	14.12.1982, 12.12.1982
10	5 29 16	-4 54.1	18.4B	1.0B	29.01.1981, 14.12.1982
11	5 29 18	-5 59.4	17.6pg	1.3pg	26.11.1979, 12.02.1983
12	5 29 27	-6 58.4	18.0U	1.4U	25.02.1982, 29.01.1981
13	5 29 28	-4 28.0	17.5pg	0.7pg	26.10.1981, 04.10.1981
14	5 29 34	-5 45.6	16.7pg	1.1pg	26.11.1979, 23.12.1982
15	5 29 35	-6 20.2	17.1pg	0.7pg	11.10.1981, 25.02.1981
16	5 29 50	-6 02.1	18.3pg	1.0pg	11.10.1981, 27.09.1981
17	5 29 50	-5 37.6	18.4pg	2.1pg	20.03.1984, 11.10.1981
18	5 31 07	-6 19.9	15.4pg	0.9pg	27.09.1981, 11.10.1981
19	5 31 16	-5 46.2	17.9B	1.2B	14.12.1982, 29.01.1981
20	5 31 25	-5 18.4	18.5B	1.3B	29.01.1981, 14.12.1982
21	5 31 39	-6 12.1	16.3pg	0.9pg	22.10.1981, 18.12.1982
22	5 32 32	-5 37.6	17.4pg	1.0pg	10.10.1978, 06.03.1978
23	5 32 44	-5 12.2	17.3pg	0.8pg	08.02.1983, 23.02.1982
24	5 33 07	-4 20.2	18.5U	4.2U	18.12.1982, 06.02.1981
25	5 33 32	-4 06.1	17.7pg	1.6pg	28.10.1979, 23.12.1982
26	5 35 13	-6 32.6	16.5pg	0.8pg	26.11.1979, 18.12.1982
27	5 35 48	-6 34.3	16.6pg	1.5pg	08.02.1983, 19.01.1983
28	5 35 57	-5 33.6	16.1pg	1.1pg	24.10.1981, 25.02.1981

characterized by Fuor-like variability in smaller scale and at maximum it has a very strong Hα emission. The identification charts of the new flare and variable stars are also given. We are continuing Abastumani (Ab) numbering (Natsvlishvili, 1982) for new flare stars. Stellar magnitudes have been determined on the plates, obtained either without filter (pg) by multiple exposure method or with UG2 (U) and GG13 (B) filters in combination with Kodak 103aO emulsion. In Table III the dates of maximum and minimum luminosity of the new variable stars are also given.

R.Sh. NATSVLISHVILI

Abastumani Observatory,
Georgia, USSR

Reference:

Natsvlishvili, R.Sh., 1982, I.B.V.S. No. 2231

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PERIOD AND LIGHT-CURVE OF THE CLOSE ECLIPSING BINARY FZ ORIONIS

FZ Orionis ($\alpha_{1950} = 5^h38^m45^s$, $\delta_{1950} = 2^o35.0'$) was discovered by Hoffmeister (1934). The General Catalogue of Variable Stars (Kukarkin et al., 1969) gives the following information: type EW?, photographic magnitude range 10.0 to 11.0, period 1.597 day (?), spectral type G0. The W UMa-type light-curve was suspected by Soloviev (1945). The period of 1.597 day is given by Kippenhahn (1953) (type β Lyrae).

Analysing 1229 visual estimates of FZ Ori made by GEOS, Figer (1983) has shown that it is a W UMa-type eclipsing binary (EW) with a period about 0.4 day. Figer's work leads to the ephemeris:

$$\text{Min I} = \text{Hel. J.D. } 2444024.4583 + 0.3999866\ E$$
$$\pm 28 \qquad\qquad \pm 18$$

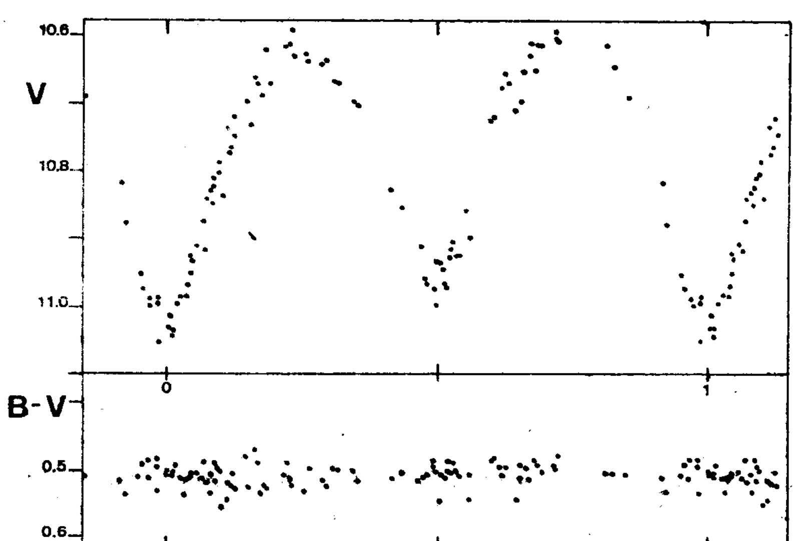

Figure 1

V and B-V light-curve of FZ Ori

In order to check this result and to obtain BV light curves (Johnson and Morgan system), FZ Ori was measured with a photoelectric photometer attached to the 1m telescope at Pic du Midi Observatory (France). FZ Ori was observed during 4 nights from 1983 December 4 to 7. These measurements alone confirm the period given by Figer (1983) and the EW nature of FZ Ori (typical V light curve and constant B-V: Figure 1). The photoelectric measurements also confirm the discrimination between primary minimum and secondary minimum as made by Figer (1983). Table I gives dates and O-C's for the 3 individual photoelectric minima obtained from 1983 December 4 to 7. The O-C values are referred to Figer's ephemeris.

Table I

	UT	HJD	O-C	type of minimum
1983 Dec 5	2^h14	2445673.598	-0.005 d	I
1983 Dec 6	2^h14	674.598	-0.005 d	II
1983 Dec 7	21^h25	676.398	-0.005 d	I

Since the star was observed during 4 successive nights only, no precise ephemeris can be computed from the photoelectric measurements alone. Lumping the 44 GEOS' visual minima (weight 1) and the 3 photoelectric minima (weight 3), one obtains the following ephemeris (95% level of confidence for the error bands):

$$\text{Min I} = \text{Hel. J.D. } 2444024.4580 \underset{\pm 25}{} + 0.3999860 \underset{\pm 12}{} \text{ E}$$

Figure 1 shows the V and B-V light curve of FZ Ori using the latter ephemeris. V magnitudes range from 10.61 to 11.02 (Min. I) and 10.95 (Min II). The mean B-V is equal to 0.51. These values are consistent with an EW type. Although no correction for interstellar extinction was made, this B-V value is in good agreement with Eggen's period-colour relation for contact binaries (1961, 1967).

J.F. LE BORGNE*[§], A. FIGER[§], M. DUMONT[§]

*Observatoire du Pic du Midi et de Toulouse
14 Avenue Edouard Belin
F-31400 TOULOUSE

[§]GEOS
12 Rue Bezout
F-75014 Paris

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FO Vir, A CLOSE ECLIPSING BINARY, NOT AN RR Lyr-VARIABLE

The sixth magnitude variable FO Vir was suspected to be an USPC with a period of 0.5 d (Eggen, 1983) as a result of two nights of observations. Previous visual estimates (Poretti, 1977) have suggested the star could be an RRc variable with a period of 0.29 d, while according to the photoelectric observations of Jackisch (1972) it could be an RR with period between 0.5-0.7 d.

In order to clear the matter we began to observe this star in the V-light at Merate Observatory in 1982. We have 4 nights of observations in 1982, 1 night in 1983 and 8 in April 1984. Due to weather conditions the 1982 observations are of poor quality, except the first night. The 1982-83 measurements have been performed at the 102 cm reflector, while the 1984 ones at the 50 cm reflector. Two comparison stars of the same spectral type (A2) have been adopted: BD +2^{o}2671 (C1) and BD +2^{o}2664 (C2). From the ΔV's between C1 and C2 the resulting standard deviation of a single measurement is 0.011 mag.

Our data permit to affirm that FO Vir is a close eclipsing binary. We have searched for its period making a simultaneous least-squares fit of the trial frequency and its two first harmonics on the 1984 observations: it results in a period of 0.776 $\pm$ 0.006 d.

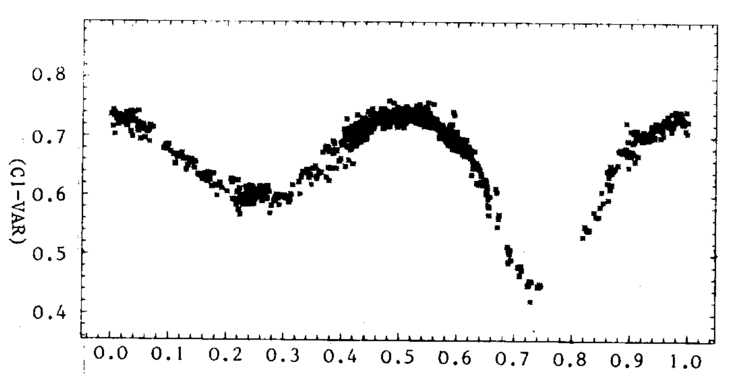

Figure 1

The 1984 data, phased with this period, have been plotted in Figure 1. As they fail to cover the primary minimum, we have added the 1983 night, which shows the descending branch, in order to get a better understanding of the light curve. This addition was made shifting arbitrarily the phases of this last night in order to get the best overlap: therefore some uncertainties remain about the real shape of this minimum.

With respect to the figure, the two Eggen's light curve probably represent the ascending branches from primary (JD 2444346) and secondary (JD 2445091) minimum.

We plan further observations in order to get a complete coverage of the light curve. We intend to publish our data and a study of the system when this task is fulfilled.

E. ANTONELLO

L. MANTEGAZZA

E. PORETTI

Osservatorio Astronomico di Brera
Via E. Bianchi, 46
22055 MERATE (CO)
Italy

References:

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ON THE VARIABILITY OF HD 205328

During observations of GK Cep M. Winiarski noticed certain irregularities in the light curve of this star. Similar irregularities were also observed before (Bartolini et al., 1965, Gleim, 1967, Dworak, 1975).

M. Winiarski observed GK Cep during 24 nights from May 4, 1977 to December 17, 1977, with a 50-cm Cassegrain telescope and a photoelectric photometer equipped with a 9789 QB tube and filter for V. HD 205328 was used as a comparison star and HD 205235 and HD 204087 as check stars.

After analysing these observations it was confirmed that the comparison star - HD 205328 - was variable. The amplitude of the variations was about $0^m.025$. Provisional elements are:

$$\text{Max.} = \text{JD } 2443268.4014 + 0^d.65415\ E$$

The mean light curve with these elements is presented in Figure 1, where

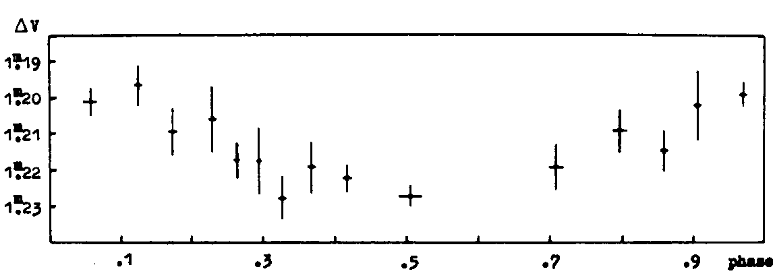

Figure 1

The mean light curve of HD 205328 in V

ΔV signifies the difference of magnitude in V between HD 205328 and HD 205235. Each point in the plot is a normal point of ten individual observations. The standard deviations of ΔV and the phase for each point are marked by solid lines.

In view of the characteristics, HD 205328 might be considered as an Alpha CVn star.

I. LELATKO

Astronomical Observatory
Jagiellonian University
Cracow, Poland

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ULTRAVIOLET ANS PHOTOMETRY FOR THE FIVE SUSPECTED LONG PERIOD Ap STARS HD 89 822, HD 137 389, HD 187 474, HD 204 411 AND HD 221 760

The main problem of the very long period magnetic CP stars is whether the nature of those stars is the same as for the "normal " short period ones. To answer this question it is necessary to determine the periods and then to compare their characteristics of variability, which certainly should be different, if different mechanisms are working. The Ap stars show pronounced typical characteristics in their UV variability, e.g. large amplitudes and antiphase relations to the visible spectral regions.

For five of the suspected long period Ap stars given by Hensberge et al. (1984), more than two single UV observations from ANS (Wesselius et al., 1982) are available (Table I).

Table I

ANS UV observations

J.D. 2400000+	15W		18		22		24		33	
HD 89822	Mg									
42350.328	4.231±	4	4.207±	3	4.326 ±	2	4.696±	3	4.836±	4
42527.971	4.222	3	4.200	3	4.317	1	4.684	3	4.831	2
42528.176	4.226	2	4.199	3	4.315	1	4.691	2	4.827	3
HD 137389	Si									
42400.006	5.302	11	5.299	7	5.523	5	5.831	15	5.964	8
.623	5.306	5	5.314	4	5.520	2	5.811	7	5.951	5
.623	5.314	6	5.311	5	5.521	3	5.814	5	5.959	6
42580.355	5.316	7	5.332	4	5.516	2	5.803	4	5.947	5
42581.507	5.328	5	5.324	4	5.519	2	5.803	4	5.955	4
.977	5.327	6	5.319	6	5.520	3	5.798	3	5.959	6
42583.872	5.315	5	5.326	3	5.515	2	5.805	4	5.956	5
HD 187474	Si Cr Eu									
42336.792	5.341	6	5.103	4	4.873	2	5.275	4	5.100	2
337.004	5.331	5	5.118	5	4.877	3	5.271	5	5.102	3
515.907	5.179	6	4.972	5	4.819	2	5.207	5	5.123	3
.907	5.186	4	4.967	4	4.815	2	5.218	3	5.121	3
880.397	5.158	2	4.966	3	4.841	1	5.216	2	5.135	2
.861	5.153	9	4.968	5	4.838	2	5.211	8	5.129	3
HD 204411	Cr Si									
42575.899	7.892	18	6.165	8	5.887	5	6.181	5	5.783	6
.899	-	-	6.144	5	5.885	3	6.193	5	5.773	4
42576.914	7.863	29	6.157	7	5.879	3	6.190	6	5.771	5

Table I (cont.)

J.D. 2400000+	15W		18		22		24		33	
HD 204411 Cr Si										
42576.914	7.866	± 19	6.157	± 8	5.884	± 4	6.186	± 6	5.782	± 5
42578.134	7.891	16	6.169	7	5.877	3	6.194	7	5.771	4
.134	–	–	6.160	6	6.879	2	6.198	6	5.770	4
HD 221760	Sr Cr Eu									
42377.901	6.222	9	5.259	6	5.048	2	5.407	4	5.045	3
.901	6.196	9	5.257	6	5.048	2	5.413	4	5.039	3
42378.105	6.226	10	5.258	5	5.055	2	5.407	4	5.044	3
.105	6.229	10	5.266	5	5.053	2	5.410	4	5.049	4
42558.656	6.180	10	5.232	4	5.048	3	5.401	4	5.037	4
42559.466	6.278	10	5.232	5	5.049	3	5.408	4	5.050	4
.466	6.292	9	5.245	4	5.050	2	5.411	4	5.050	4
.470	6.274	10	5.235	5	5.052	2	5.414	5	5.048	4
42743.556	6.202	8	5.263	4	5.044	4	5.410	6	5.047	4
.556	6.187	10	5.257	4	5.041	3	5.406	4	5.050	3
42744.626	6.236	10	5.267	5	5.050	2	5.411	3	5.044	2
.630	6.218	12	5.268	5	5.051	3	5.409	4	5.048	3

For three of the stars (HD 89 822, HD 137 389, HD 204 411) no significant variations have been found. That means that HD 89 822 and HD 137 389, if variable, have periods, much longer than 180 days. For HD 204 411 found to be constant in the visible by different authors, one can exclude UV variability with a period less than 10 days. For HD 221 760 the observed magnitude differences, at least in the wide 1550 A band are significantly greater than the errors. The short time scale of variations suggests a period length in the order of days.

The star HD 187 474 clearly shows variations which agree with the time scale given by Hensberge et al. (1984). Assuming similar shapes of the light curves in u and in the near-by 3300 A band and shifting the magnitude scale to fit the two sets of observations, we can correct the period given by the above mentioned authors. This leads also to a little better agreement between the uvby observations. The obtained elements are:

$$\text{JD (phase zero)} = 2444457.77 + \underset{\pm 50}{2300}\cdot E$$

Figure 1 shows the observations plotted in the phase diagram. The visible magnitudes were taken from Figure 1 of Hensberge et al. (1984), the phases were computed from the mean time of the corresponding observing runs, given there (+absolute measurement). The dashed lines indicate our interpretation of the observations. The distribution of the observations at different wavelengths in the phase diagram suggests a double wave in the light curves. The variations in the UV have large amplitudes and are in antiphase to the

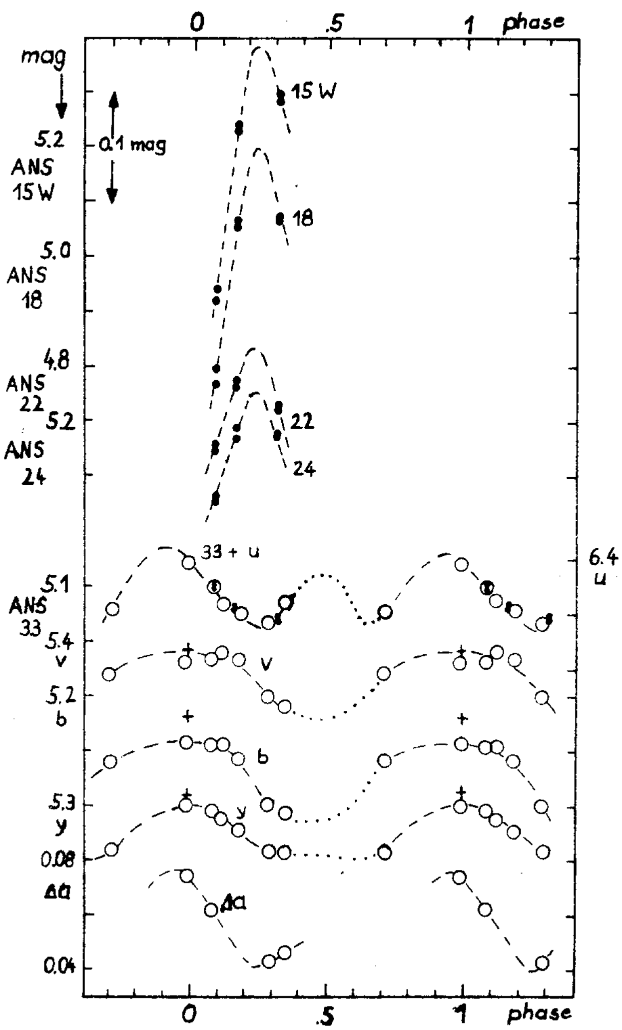

Figure 1

variations in the visible spectral region including the 3300 A band. The characteristics of the photometric variability of this very long period (6.2 years) star are very similar to normal short periodic Ap stars, suggesting intrinsic slow rotation and rotational variability for HD 187 474. The intermediate long period Ap stars HD 221 568 (P = 159 d) and HD 188041 (P = 224 d) clearly show rotational variability. Now HD 187 474 extends this property to much longer periods. Therefore it does not seem to be necessary to assume generally any other mechanism for explaining the very long period Ap stars. On the other hand, the expected short rotational period, estimated by Kurtz (1983) from his oblique pulsator model for Gamma Equ in connection with the long time scale variations of the magnetic field (s. Krause, Scholz, 1981) might indicate that for different long period magnetic CP stars different mechanisms can be responsible for their variability. We thank Dr. Wesselius, who made it possible to use the individual observations from ANS.

WERNER SCHÖNEICH

Zentralinstitut für Astrophysik
1502 Potsdam-Babelsberg
Rosa-Luxemburg-Str. 17a
GDR

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A NEW PERIOD CHANGE OF 44i BOOTIS IN 1979*

Seven infrared light curves (λ = 2.25 μm) of the contact binary 44i Bootis were obtained in April 1980 included five complete curves secured on a single night. The 585 individual observations will be published and fully discussed elsewhere (Lunel et al., 1984).

The comparison of the new curves (April 1980) with the curves of March 1978 published by Bergeat et al., (1981) led us to the conclusion that the period should have changed during the meantime. Heliocentric epochs were computed by the method of Kwee and van Woerden (1956):

Table I

Night (1980 April)	Hel. J.D. Prim.min. (2444300+)	O-C in days (elements of Duerbeck 1975)	(new elements this paper)
19-20	49.39044	+0.0034	+0.0011
21-22	51.53145	+0.0019	-0.0005
24-25	54.47726	+0.0017	-0.0006
25-26	55.55004	+0.0032	+0.0009
26-27	56.35231	+0.0020	-0.0003

The O-C diagram for primary minima is given in Figure 1 which includes our infrared data of March 1978 (triangles, observations published by Bergeat et al., 1981) and the above-mentioned results (squares). Minimum times observed by Hopp et al., (1977), Duerbeck et al., (1978), Duerbeck (1978), Margrave (1980, 1982) Mikolajewska and Mikolajewski (1980), Pohl and Gülmen (1981) Rovithis and Rovithis-Livaniou (1981), Hopp and Witzigmann (1982) and Robb and Milone (1982) are denoted by dots.

Despite the wide scatter observed around JD 2443600, it is clear that some period change should have occured between this former value and JD 2444350. As a weighted mean of the available data, we propose the following elements:

$$2443944.9851 + 0^{d}.2678174 \; E.$$

*The observations were done at the Observatoire de Haute-Provence (CNRS).

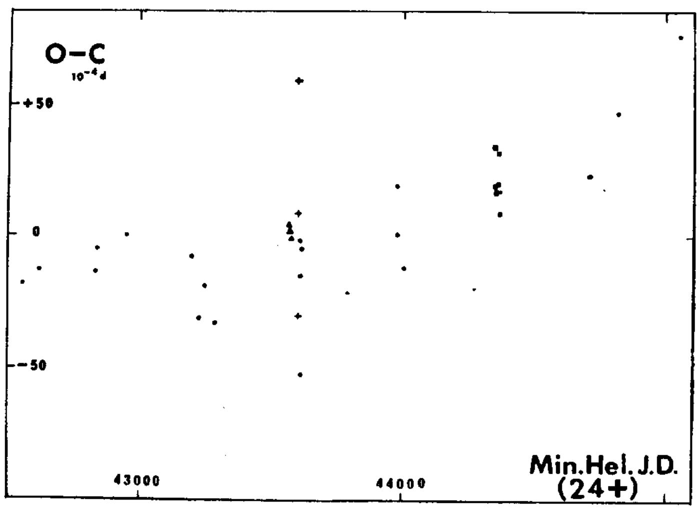

Figure 1

The diagram of O-C (in days) for primary minima against the heliocentric epoch, as recently observed in the contact binary 44i Bootis.

Much more data is needed so as to improve these provisional elements. We note that the new period lengthening (i.e. + 15 x 10^{-7} day) has an amplitude comparable to the previous one reported by Bergeat et al., (1972). Presumably the period change occured in 1979. It is noteworthy that Hopp and Witzigmann (1982) reported an active phase of i Bootis in 1979, while 1978 and 1981 would have been more quiet.

Finally the authors wish to emphasize the necessity of having recent and accurate elements at hand when studying features of light curves such as asymmetries. An undetected recent change of small amplitude on the period result in spurious asymmetries. In particular, the odd sine term b_2 becomes detectable.

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J. BERGEAT

M. LUNEL

R. GARNIER

Observatoire de Lyon
69230 Saint Genis Laval
France

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RADIAL VELOCITY VARIATIONS IN THE Ca II EMISSION STAR HD 36705

We present radial velocity measurements which suggest that the star HD 36705, previously thought to be single, is in fact a single lined binary.

HD 36705 (K1 IIIp, Houk and Cowley, 1975) shows strong Ca II H & K emission, and was suggested as a possible RS CVn star (Weiler and Stencel, 1979). However Collier (1982) found no radial velocity variations in ten spectrograms of this star, and concluded that it is probably a member of the FK Comae class of rapidly rotating single late type giants (Bopp and Stencel, 1981). Pakull (1981) identified HD 36705 with a flaring X-ray source observed by the EINSTEIN satellite. He also obtained extensive photometric observations, finding a period of 0.51423 ± 0.00005 day, and a light curve which changes significantly on short time scales. Rucinski (1983) obtained further photometry, confirming the short period and the rapidly varying light curve. Collier et al.(1982) and Slee et al.(1984) report a possible detection of this star at radio frequencies.

We obtained 14 spectra of HD 36705 at a dispersion of approximately 10 Å mm^{-1} with the Cassegrain echelle spectrograph on the 1.0 m telescope of the Australian National University at Siding Spring Observatory on 1984 February 16, 19, 20 and 21. The detector was the Mount Stromlo red two dimensional Photon Counting Array. All data reduction was done with the Mount Stromlo PANDORA reduction program.

We also made eleven measurements of four stars whose radial velocities are accurately known from the work of Griffin (1972). The mean deviation of our results from those of Griffin is -0.9 km s^{-1}, with an rms error of 2.5 km s^{-1}. The measured radial velocities of HD 36705 are likely to be less precise, due to the high rotational broadening ($v \sin i$ = 70 ± 10 km s^{-1}, Collier, 1982).

Only about 0.8 of the approximately half day period was covered by our observations, with only about 0.6 well covered. The data indicate a radial velocity variation of at least 20 km s^{-1}.

We combined our data with those previously published by Collier (1982). We retained the epoch of Pakull (1981) of HJD 2444296.575, but the combined radial velocity data spanning four years are better fitted by a period of 0.51425 day. Our derived period is consistent with that of Pakull within his quoted uncertainty.

The radial velocity data are plotted in Figure 1, (open circles: Collier, 1982; closed circles: our results) with the epoch and period given above. A best fitted sine wave is also plotted; the equation is

$$V = 36.9 + 10.9 \sin 2\pi(\phi - 0.137)$$

where ϕ = phase as computed from the given epoch and period.

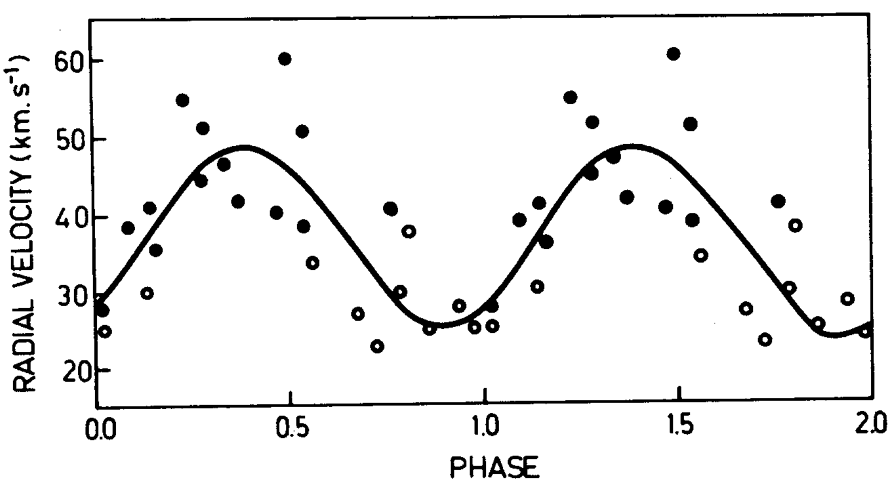

Figure 1

Although the data are scattered, we believe the variations to be real. We suggest that Collier's (1982) conclusion can be explained by the fact that his measurements were made when the velocity was not changing greatly with phase.

The amplitude of the line of sight orbital velocity is about 10 km s^{-1} and the line of sight rotational velocity is 70 ± 10 km s^{-1} (Collier, 1982). Assuming synchronous rotation, these results imply that the centre of mass of the system is well within the visible component and that the mass ratio q is < 0.1.

The large rotational velocity of the primary implies that it cannot be a giant, because of equational break up; thus the secondary must be a very low mass object.

Hearnshaw (1979) obtained eleven spectra of this star, and suggested that radial velocity changes may be present. However, no numerical results were given, so we cannot compare Hearnshaw's results with our data.

Figure 2 is a photoelectric V light curve obtained during 1984 February

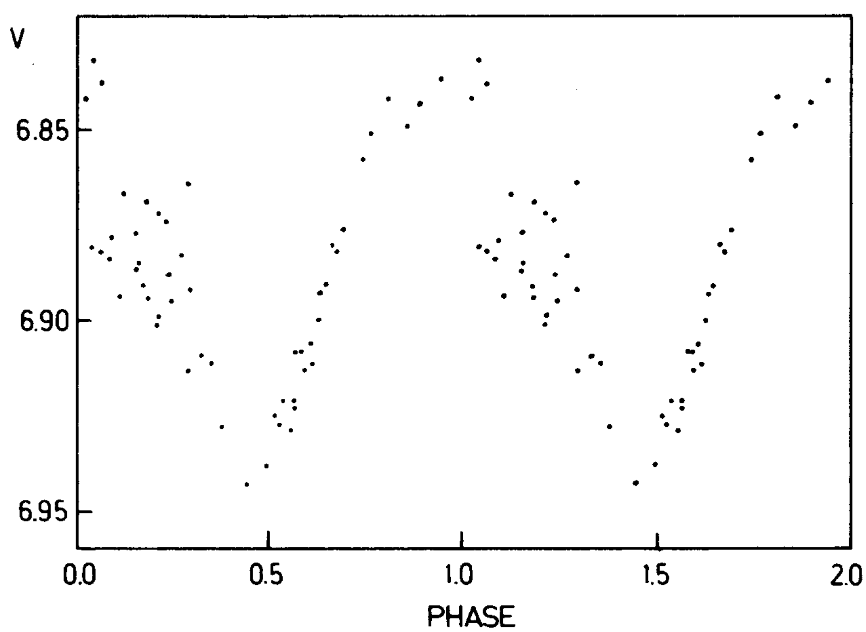

Figure 2

to April, with the Monash Observatory 0.25 m telescope, using a 1P21 photo-multiplier tube. All measurements were made differentially using HD 37297 as a comparison star, as used by Pakull (1981). These data are plotted with the same epoch and period as Figure 1. The results suggest that minimum light occurs near radial velocity maximum. If the photometric variations are due to dark starspots then maximum spot visibility must also occur at this orbital phase.

We are preparing a fuller account of this work for publication elsewhere. We thank Mount Stromlo and Siding Spring Observatories for access to the 1.0 m telescope and other facilities.

J.L. INNIS, D.W. COATES and K. THOMPSON
Department of Physics, Monash University
Clayton, Victoria, Australia, 3168

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UNUSUAL LIGHT VARIATIONS OF THE CARBON STAR AFGL 2881

We studied light variations of the infrared object AFGL 2881 (Price and Walker, 1976) on plates taken with the Schmidt telescope of the Radioastrophysical Observatory. The finding chart published by Cohen and Kuhi (1977) was used for identification of the optical counterpart of the object.

The character of light variations of this carbon star turned out to be rather unusual.

At first, from June 1975 till Dec. 1978 (J.D. 2442572 - 2443858) the star behaved as a long-period variable (Fig. 1). At the maximum light the red magnitude m_R was 10.8 ÷ 11.1, m_V = 13.0 ÷ 13.4 and $m_B \simeq 18$ (the object is visible only on one B-plate). At the minimum light $m_R \simeq 13.0 \div 13.7$, $m_V \simeq 15.0$. The three observed maxima give the following light elements

$$\text{Max} = \text{J.D. } 2442690 + 560\,E \tag{1}$$

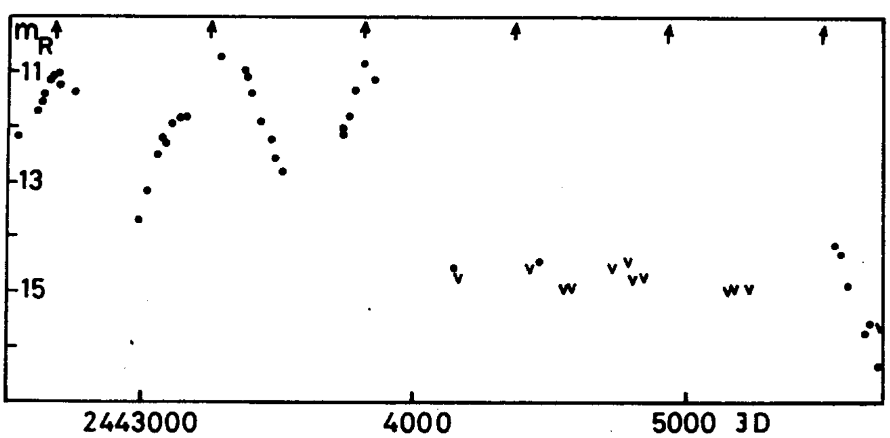

Figure 1. The m_R light curve of the object AFGL 2881. "v" stands for observations below plate limit. Small arrows at the top represent the predicted dates of maxima.

On plates taken later, however, the star was unexpectedly faint. On most of the 13 red plates taken between Oct. 1979 and Oct. 1982 the star was below plate limit, and never was seen brighter than $m_R = 14.4$, even at phases 0.14 and 0.87 according to the equation (1). During the observing season 1983 when exposures were made longer than previously, the star was observed declining from $m_R = 14$ at the beginning to $m_R = 16$ at the end of the season.

Thus our observations indicated that after Dec. 1978 the star AFGL 2881 faded in red light by two to three magnitudes in comparison to the earlier mean light curve.

More details on the variability of the AFGL 2881 will be given in a forthcoming paper in the Investigation of the Sun and Red Stars.

It would be important to know how rapidly the star faded and what was its photometric behaviour during the long interval of faint light. It is highly desirable to look through suitable red or V-plates, at least those taken after 1978 in plate collections of other observatories. It would be also interesting to compare the optical variations with those in infrared.

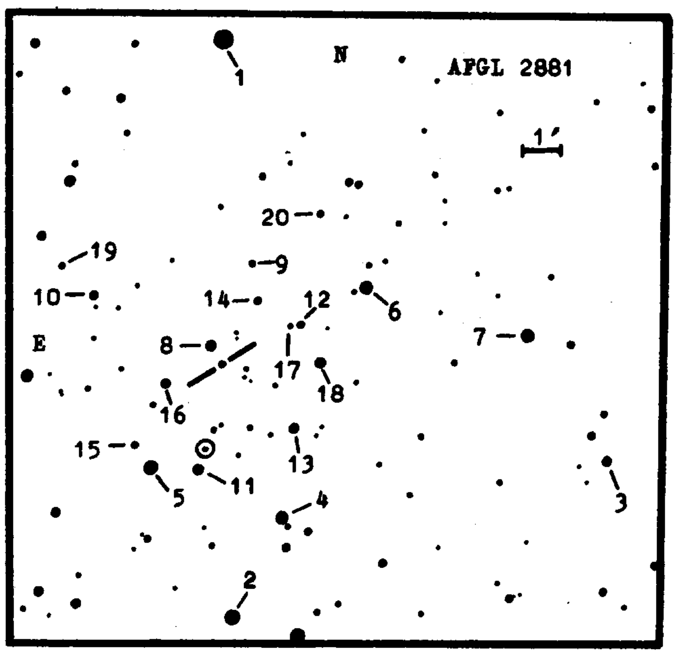

Figure 2. The finding chart for AFGL 2881 (R.A. = $22^h16^m.5$, Decl. = $+43^\circ32'$, 1950) and comparison stars. The anonymous red star (see text) is marked with a circle.

Not less interesting would be to follow possible return of the star to its previous bright condition.

Probably, the star AFGL 2881 faded because of additional dust expelled from its surface as in the case of the variable carbon star HV 2379 (Bessell and Wood, 1983).

On the objective prism plate taken in Aug. 1974 we found another very red star 2.2 arcmin south of the AFGL 2881. It is ~30 arcsec north of comparison star No.11 (Figure 2). On this particular plate the anonymous red star turned out to be about 1.5 mag brighter than AFGL 2881, contrary to that seen on direct plates taken later. Positions of both red stars support identity of AFGL 2881 with the star No.3125 in the General Catalogue of Cool Carbon Stars (Stephenson, 1973), or with the star Case 749 (Blanco, 1956), suggested by Altamore et al. (1980). On our plates in most cases this anonymous red star is below plate limit. However, long-period variations with preliminary cycle length of about 440^d for this red star are suspected.

A. ALKSNIS and A. RUDZINSKIS

Radioastrophysical Observatory
Latvian Academy of Sciences
Riga, Latvia, U.S.S.R.

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PERIOD VARIATION IN THE WHITE DWARF ECLIPSING BINARY V 471 TAURI

Since the discovery of eclipses in this peculiar binary V 471 Tauri at the end of December 1969 by Nelson and Young (1970) various photometric and spectroscopic studies have been published. It has a wave-like distortion in its light curve, H and K emissions and a variable orbital period.

The period variation was first discussed by Young and Lanning (1975) and the systematic variations in the period have been explained by active mass transfer. They noted that the period had increased and decreased over 3300 cycles following its discovery and current models were not adequate to account for such variations when one component is a white dwarf. The same material was interpreted by Herczeg (1975) and a light time effect in an eccentric orbit around a third body was suggested. He objected to the suggestion of Young and Lanning on the grounds that the system was a detached one and there was no other evidence for mass flow. Later, Rucinski and Oliver (1978) collected all the times of minima obtained until November 1976 and discussed the period changes. They separated the available O-C's into three groups and fitted three straight lines. In order to determine the decrease in the period a parabolic fitting was applied by Tunca et al. (1979). Their calculations indicated that the period of the system decreased by about one second per century.

The times of minima obtained between 1979 and 1983 by the authors are given in Table I. The O-C residuals are the deviations from the light elements given by Young and Lanning (1975) as

$$\text{Min. I} = \text{JD(Hel.)}\ 2440\ 610.0649 + 0^{d}.52118346\ E\ .$$

Table I

Min. (Hel.)	O-C (I)	E
2444 876.47018	$-0^{d}.00252$	8186
911.38954	.00246	8253
2445 284.55656	.00279	8969
612.38065	.00310	9598
614.46546	.00302	9602
695.24889	.00303	9757

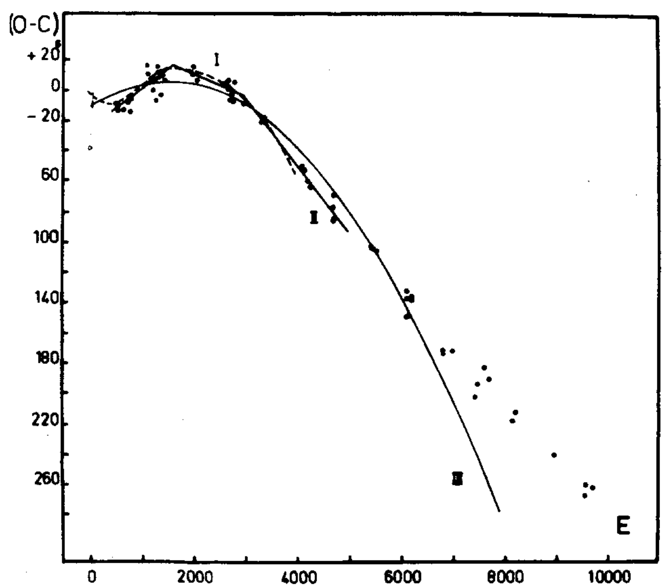

Figure 1.

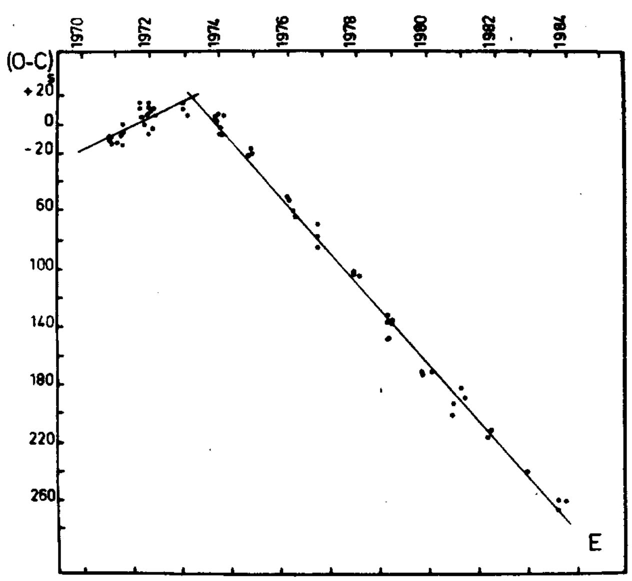

Figure 2.

All of the times of minima obtained so far have been collected and the deviations from the light elements given above have been computed. In Figure 1 the O–C values are compared with the light elements given by Young and Lanning (1975, curve I), Rucinski and Oliver (1978, line II) and Tunca et al. (1979, curve III). As it is seen the times of minima obtained in the last five years do not agree with those light elements. Therefore we have separated the O–C values into two groups, viz. $0 < E < 2400$ and $2700 < E < 10\,000$. In this case linear light elements agree well with the O–C values. An application of the least squares gave the following ephemeris:

for the first segment, $0 < E < 2400$

$$\text{Min.I} = \text{JDHel.}2440\ 610.06470 + 0\overset{d}{.}52118365\,E$$
$$\pm 4 \qquad\qquad\qquad \pm 3$$

for the second segment, $2700 < E < 10\,000$

$$\text{Min.I} = \text{JDHel.}2440\ 610.06614 + 0\overset{d}{.}52118301\,E \quad .$$
$$\pm 3 \qquad\qquad\qquad \pm 1$$

From Figure 2 it is seen that the linear segments join together in about 1973. This result indicates that a decrease in the period occurred suddenly in 1973. The second segment would be useful for prediction of the eclipses in the near future. For prediction of the first contact 0.017083 day should be subtracted from the computed time of mid-eclipse.

C. IBANOĞLU and S. EVREN

Ege University Observatory
Bornova - Izmir, Turkey

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HD 126200 - A SUSPECTED ECLIPSING BINARY ?

The star HD 126200 (=BD + 8°2857) has now been listed by Kukarkin et al. (1982) as a suspected eclipsing binary of Algol type with a variation of 0.5 magnitude based on the findings of Sandig (1951). Hirschfeld and Sinnott (1982) have listed its magnitude, colour, radial velocity and spectral type. No other information about the star is available in the literature.

We have observed this star for a total duration of about eighty hours spread over two nights in 1967, eighteen nights in 1968 and two nights in 1970 through U, B and V filters of Johnson and Morgan system, mostly through the 52-cm reflector and on only two nights through the 56-cm reflector of the Uttar Pradesh State Observatory, Naini Tal, using standard d.c. techniques. HD 126676 (=BD + 9°2890) and HD 125608 (=BD + 9°2878) were taken as comparison stars. HD 125608 was observed on only two nights along with the other two stars. Our observations of individual nights do not show any noticeable variations in U, B or V magnitudes. Therefore, we conclude that HD 126200 is not an eclipsing binary star. The average colour and magnitude of these stars based on eleven nights of observations, on which standard stars were also observed, are listed in Table I along with their right ascension, declination and spectral type (Hirshfeld and Sinnott, 1982).

Table I.

Star	α_{2000}	δ_{2000}	V	B−V	U−B	Sp.
HD 126200	$14^h24^m00^s.8$	$+8^{\circ}14'37''$	$5^m.80$	$+0^m.03$	$0^m.12$	A0
			$\pm 0^m.18$	$\pm 0^m.09$	$\pm 0^m.28$	
HD 126676	14 26 47.3	+8 22 55	7.56	0.00	+0.02	A0 V
			±0.16	±0.06	±0.12	
HD 125608	14 20 20.8	+8 34 56	7.29	+0.98	+0.42	G5 IV

The participation during the observations by Messrs R.K. Srivastava and G.S.D. Babu is thankfully acknowledged.

J.B. SRIVASTAVA and C.D. KANDPAL
Uttar Pradesh State Observatory,
Manora Peak, Naini Tal - 263129,
India.

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PHOTOELECTRIC OBSERVATIONS OF o And

Recently there is a growing interest in Be stars (Harmanec, 1983) and special attention has been paid to o And. Since the puzzle of its light variation is not yet solved, any observations unpublished until now may help. Therefore the photoelectric observations obtained by the 60 cm telescope at Konkoly Observatory are given in this note.

The observations (Table I) are corrected for atmospheric extinction and transformed to the standard BV system. 2 And = HR 8766 was used as comparison star (V = 5.10, B-V = +0.09, Hoffleit, 1982) but no check has been made on its constancy.

Table I

Photoelectric observations of o And

J.D.	ΔV	Δ(B-V)	J.D.	ΔV	Δ(B-V)
2436801			2436802		
.5030	-1.425	-0.263	.4471	-1.471	-0.265
.5142	-1.422	-0.265	.4506	-1.487	-0.259
.5203	-1.422	-0.265	.5660	-1.508	-0.245
.5258	-1.429	-0.265	.5738	-1.496	-0.243
.5314	-1.418	-0.278	.5791	-1.503	-0.246
.5369	-1.430	-0.268	.5859	-1.510	-0.250
.5425	-1.423	-0.271	.5912	-1.517	-0.243
.5480	-1.425	-0.262			
.5536	-1.426	-0.261	2436803		
.5591	-1.427	-0.262	.3790	-1.447	-0.247
.5647	-1.427	-0.267	.3866	-1.453	-0.243
.5703	-1.419	-0.264	.3921	-1.456	-0.247
.5758	-1.426	-0.261	.3975	-1.454	-0.248
.5814	-1.422	-0.262	.4025	-1.445	-0.254
.5869	-1.418	-0.263	.4081	-1.456	-0.247
.5932	-1.432	-0.258	.4136	-1.459	-0.248
			.4192	-1.462	-0.236
2436802			.4248	-1.455	-0.240
.4290	-1.450	-0.266	.4301	-1.457	-0.249
.4367	-1.469	-0.256	.5760	-1.449	-0.242
.4423	-1.469	-0.267	.5804	-1.447	-0.262
			.5842	-1.447	-0.248

The data may represent an extension of H. Schmidt's (1959) observations and confirm the short term variability of the star.

B. SZEIDL

Konkoly Observatory
1525 Budapest, P.O. Box 67
Hungary

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SPECTROSCOPIC OBSERVATIONS OF PU Vul

The peculiar nova-like variable PU Vul was observed on July 3,5,9,1984 using the grating spectrograph at the Nasmyth focus of the 60/90-cm Schmidt telescope of Beijing Observatory. The emulsion used was Kodak 103aF. The spectral range was 3500-6700Å. The reciprocal dispersion was 167Å/mm. The spectral features were almost the same as those on December 11,1983 (Liu Zongli, Hao Xiangliang, IBVS, No. 2466, 1984). The main absorption lines were H_γ-H_{10}, Ca II H,K, Fe II and Ti II. The H_β was filled with emission. The Hα emission was quite strong still.

Since 1982 the Hα emission has remained for two years. Since 1981 PU Vul has been always at maximum light according to Kolotilov et al. (IBVS, No. 2097, 1982), Purgathofer et al.(IBVS, No.2291, 1983) and our photographic observations.

Besides our observations, we have reviewed the overall behaviour of this object. All phenomena observed for this star led us to suggest that this object should be an exceptionally slow nova. And it may be a binary which consists of an M giant and a hot component. Due to the mass exchange and accretion of the hot component the temperature of the hot component increased. Many mini-eruptions happened and a great deal of material was ejected. Thus there is a lot of circumstellar matter around the hot component. This matter produces a large amount of extinction at the short wavelength and changes its distribution of radiation. So this binary shows the spectral type of the M giant in general. And it shows the spectral type of the A or F giant only during the maximum light. This model might explain most of the observational results, such as the spectral type of M4 on August 30, 1958 (C.B. Stephenson, IAUC, No.3356, 1979), the spectral type of M4 on September 6.59, 1978 (K. Ishida, IAUC, No.3350, 1979), the spectral type A or F during the maxima of 1979 (Gershberg R.E. et al., Soviet Astron. J., 1982, 59, No 1, 6-14) and 1981-1984, and the spectral type of M at the phase of the rapid decrease of brightness and at the minimum in 1980 (Gershberg R.E. et al., Soviet Astron. J., 1982, 59, No 1, 6-14). The circumstellar matter makes the Balmer decrement so large that only the H_α emission could be seen in general. The H_β emission could only sometimes be seen. The diluted radiation from a hot star is sufficient to excite the $D_{1,2}$ emissions, Balmer emissions and the nebular lines of [N II] and [O III]. The orbital inclination of PU Vul may possibly be small, so no indication of orbital motion could be seen.

LIU ZONGLI
Beijing Astronomical Observatory
Academia Sinica
Beijing, China

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V 1050 Aql NOT OF U GEMINORUM BUT OF MIRA TYPE

The following notes exist in the literature on this variable star (= S 8194):

C. Hoffmeister, Astron. Nachr., 288, 49 (1965) - discovery, U Gem type, maxima comparatively numerous;

M. Petit, Ciel et Terre, 86, 229 (1970) - U Gem type?, cycle length $> 80^d$;

N. Vogt and F.M. Bateson, ESO Scient. Prepr. 161 (1981) - no additional confirmation, map.

When estimating the star on Sonneberg astrographic plates centered at γ Aql I noticed that it is a Mira variable with a period of about 291 days; elements and light curve will be published in Mitt. Veränd. Sterne. On the charts of the POSS and therefore on Vogt's and Bateson's map, near the position of the variable three stars can be seen, which are not separated on our plates. The south-preceding star of this triple is a red and should be the Mira variable. Whether the bluish star marked by Vogt and Bateson at the triple's centre as being V 1050 Aql is also variable cannot be proved by our plates.

H. GESSNER
Sternwarte Sonneberg
Zentralinstitut für Astrophysik
der Akademie der Wissenschaften
der DDR

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PHOTOGRAPHIC AND PHOTOELECTRIC OBSERVATIONS
OF NOVA VULPECULAE 1984 NEAR MAXIMUM

The brightness of Nova Vul 1984 was estimated on plates of the Sonneberg Sky Patrol taken by H. Huth. On 29 and 30 July the brightness was about that of SAO 87162. The result is somewhat uncertain because of the bad position of the Nova on the plates. The brightness of SAO 87162 (V=8.94, B-V=0.14) was linked with the 60 cm-I-telescope at Sonneberg, on August 12, photoelectrically to SAO 87213 whose international UBV values are given by Blanco (Photoelectric Catalogue, 1970); all the other brightness differences determined photoelectrically are also relative to SAO 87213. During all the nights the difference between SAO 87211 and SAO 87213 was found to be constant within the observational error. 16 sec integrations and symmetric measurements were made. The weather conditions were sometimes very poor.

Table I

Photographic observations

1984	J.D. - 2445900	m_{pg}	Field 20°
July 25.972	07.472	$>13^m.5$	19^h, 20^h
29.922	11.422	9.2	19
29.963	11.463	9.2	20
30.917	12.417	9.2	20
30.917	12.417	8.9	19

Table II

Photoelectric results

1984	J.D. - 2445900		V		B-V		U-B
July 30	12	$^d.358$	$8^m.62$	$^d.362$	$^m.48$	$^d.370$	$-^m.64$
	12	.421	8.56	.415	.46	.406	-.62
31	13	.375	7.75	.379	.44	.386	-.55
	13	.419	7.74	.422	.45:		
Aug. 03	16	.378	7.12	.382	.52	.390	-.39
12	25	.360	8.06	.364	.46	.374	-.74
12	25	.443	8.06	.445	.43		

(in front of the brightness value the fraction of the Julian day is given)

Typical errors of the given mean values are 7, 10, 10 mmag for V, B-V and U-B, respectively.

The comparison of the photographic and photoelectric values on July 30 gives a good agreement despite the bad position of the Nova on the plates.

R.H. SCHULT
Sternwarte Sonneberg
Zentralinstitut für Astrophysik
der Akademie der Wissenschaften
der DDR

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Ca II H AND K, AND H_{α} EMISSION VARIABILITY IN AR LACERTAE

AR Lac (= BD + 45°3813) is a well known RS CVn type eclipsing binary system. Many interesting phenomena are associated with the system such as light curve variations, star spots and radio flares. Many investigators found it to be a source of radio emission. Recent photoelectric observations by Kurutac et al. (1981), Srivastava (1981) and Evren et al.(1983) found it to be an active system. Srivastava (1983) reported optical flares present in the system.

The presence of CaII H and K emission has been detected in AR Lac by Wyse (1934), Naftilan and Drake (1977), Weiler (1978) and Naftilan and Aikman (1981). These authors found rapid (hourly) variability of CaII H and K emission, but could not establish any correlation of the variability of emission either with the orbital phase of the system or with the migrating photometric wave.

In order to find the activity of the system in 1983, the system AR Lac was observed spectrophotometrically on 20 November 1983 with the 104-cm reflector of Uttar Pradesh State Observatory. A Hilger and Watts monochromator having a dispersion of 70 Å mm^{-1} was used. The exit slit corresponding to a band pass of 20 Å was used for obtaining the spectral scans in the H_{α} and $\lambda\lambda$3600 - 5000 Å wavelength region. Ten spectral scans of the system secured in the CaII H and K region and four in the H_{α} region (between phase 0.863 to 0.877) are shown in Figure 1. Although the noise is present in our scans, yet some important features are noticeable.

Looking at Figure 1, it is evident that in the first two scans, the H line emission of CaII is stronger than the K line emission. In the third scan, the K line emission seems to have either disappeared or merged with the H line emission. In the fourth scan, the K line emission has reappeared. In the fifth scan, the K line emission seems to have either disappeared or merged with the H line emission again. In the sixth scan, the K line emission has reappeared and the H line emission has become double peaked.

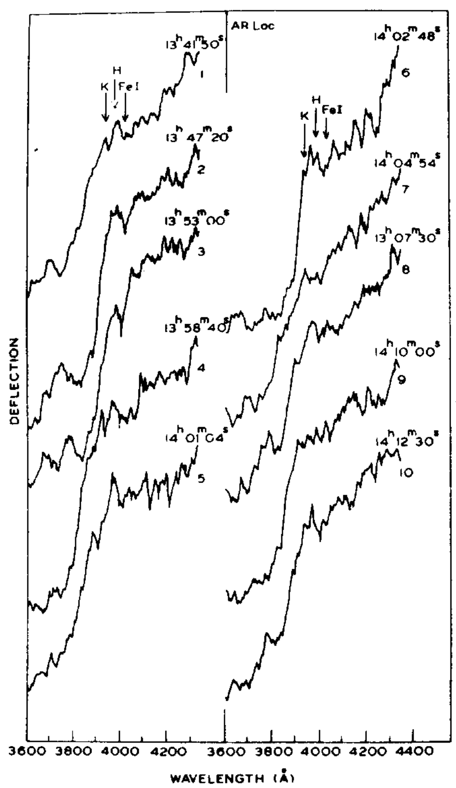

Fig.1. CaII H and K line scans of AR Lacertae. Vertical lines in the figure indicate the position of CaII H and K, and FeI lines. The time on the scans is shown in UT.

The seventh scan indicates that the K line emission has become stronger than the H line emission. In the eighth and ninth scans, the two line emissions appear to have merged. In the tenth scan, the H line emission became stronger than the K line emission.

Also, the fourth, fifth and sixth scans show that the H line emission of CaII is blue shifted from the position of the line centre. The seventh and ninth scans show that the H line emission is minutely shifted towards red. In addition, it is apparent from the first and eighth scans that the H emission feature is broader than seen in other scans. The scans also indicate that CaII H and K emission is surrounded by absorption which may be

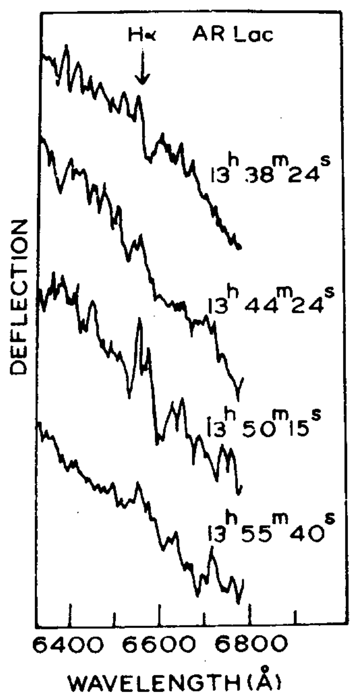

Fig. 2. H_α line scans of AR Lacertae. The vertical line in the figure denotes the position of H_α line. The time on the scans is shown in UT.

originating in a thick shell.

The position of H_α line is shown in Figure 2. The H_α line is also seen in emission. In the uppermost scan, the H_α emission is single peaked, while in the remaining scans it is seen as double peaked emission. Also, the line of H_α emission is broadest in the last scan in comparison to the other scans. The shift of H_α emission line from its line centre is not detectable.

The FeI line is seen apparently in absorption. Its features are not clear, yet some shift is seen in the line from its line centre.

We conclude from the present observations that CaII H and K, and H_α emissions are variable. These emission features change both their shape and intensity. The CaII H and K emissions seem shifted sometimes towards blue and at times towards red side from the line centres. Also, the variability of these emissions is not regular but random. In addition we can say that short-term (as short as 3 minutes) emission variability is present in AR Lac. The source of these emissions is not stable.

Wilson and Skumanich (1964) concluded that mere presence of CaII H and K emission in late-type binaries implies active chromospheres and the presence of variable H_α emission further supports this conclusion. Thus we infer that an active and dynamic chromosphere exists in the system AR Lac.

Since our observations are centered around 0.87 phase (outside the eclipse) and the scans are not taken at the eclipse phase, hence it is difficult to infer which of the component of the eclipsing binary system AR Lac is contributing to these emissions. We have mentioned above that at times double-peaked emissions are also noticed, hence the possibility of contributions from both the components cannot be ruled out.

P.S. GORAYA and R.K. SRIVASTAVA
Uttar Pradesh State Observatory,
Manora Peak, Naini Tal - 263129,
India.

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HD 91948 IS NOT A Be STAR

Goraya and Padalia (1984) have recently suggested that HD 91948 is a Be star. This suggestion is based on a single spectral scan that shows that the hydrogen lines of HD 91948 are missing or filled in by emission, a poorly documented measurement of B-V (Padalia 1980), and the similarity of the color variations of HD 91948 observed on one night by Padalia (1980) to those of the Be stars 88 Her and Pleione. We wish to point out that their conclusions conflict with the published data on this star and offer an alternate interpretation.

Gorza (1971) obtained 37 12 Å mm^{-1} spectrograms of HD 91948 during the period 1969-1971. He tentatively classified the star F6V. This is consistent with Perry's (1969) uvby photometry and the S2/68 ultraviolet fluxes (Thompson et al. 1978). These data show no evidence of either reddened or unreddened continuum radiation from a source hotter than 6500 K. We also note that the energy distribution of HD 91948 shown in Figure 2 of Goraya and Padalia (1984) appears to be somewhat redder than that of their F0V comparison star.

Padalia (1980) measured B-V=+0.016, and suggested that HD 91948 is an A0V star. His wording suggests that he does not attach a great deal of weight to this suggestion because he lacks U observations. However, Goraya and Padalia (1984) claim that 'From his photoelectric observations he determined its spectral type to be A0V.' It is not clear from the text of Padalia's (1980) note how the B-V measure was calibrated. The wording implies that it is based on adopted colors for the comparison star, but these are not documented. Since there are better photometric data which conflict with this measure, we believe that it should be ignored.

The similarities of the color variations of HD 91948 to those of some Be stars is a very weak argument for the Be classification. There are many types of small-amplitude photometric variables that have larger variations in the ultraviolet. Thus the case for the Be nature of HD 91948 rests solely on the apparent hydrogen emission observed by Goraya and Padalia in their spectrum scan of 29 April 1984. In view of the data cited above, it is clear that a Be model is untenable and some other explanation must be sought.

We considered the possibility that Goraya and Padalia observed the wrong star, but we can find no obvious candidate for a misidentification. One of us (CTB) examined all of Gorza's spectra and found no evidence for any emission. This suggests that the emission appears infrequently. Since no information is given on the instrumental configuration used to obtain the observations, it is also possible that the emission observed by Goraya and Padalia is due to the visual companion. Since it is at least 3' away from the primary along a line perpendicular to the slit, it would not have contaminated any of Gorza's spectrograms, but a wider slit may have been used for the scanner observations.

The visual companion is estimated to be slightly more than 4 mag fainter than HD 91948, which would give it a spectral type near M0 if it forms a physical system with HD 91948. The unseen spectroscopic companion could also be a dM star. Goraya and Padalia's observations suggest that one of these stars is a flare star. The observed emission (or absence of absorption) in the spectrum scan and the color and time dependences of the photometric variations can all be accounted for if one of the companions occasionally flares by 3-4 mag for a few hours. These would be large flares, but they fall within the range of behavior observed in the dMe stars.

C.T. BOLTON and RON W. LYONS
David Dunlap Observatory
P.O.Box 360
Richmond Hill, Ontario L4C 4Y6
Canada

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NEW FLARE STAR

The serendipitous discovery of a new flare star on an ultraviolet plate taken with the 1.2m UK Schmidt Telescope at Siding Spring Observatory, Australia, is reported.

A new guiding facility on the 1.2m UK Schmidt Telescope allows the telescope to track a fast moving comet during a long exposure. The telescope is moved at a pre-programmed rate of offset from the guide star, calculated from the known direction and speed of the comet across the sky. Consequently, all star images appear as trails with identical micro-irregularities in their signatures. Any non-trailed or unusual image can be easily identified.

The flare was noticed on a 90 minute U plate using the previously described technique on Comet Crommelin. The flare star was identified visually on the SERC J Southern Sky Survey. A flare of about 1.5 mag. above a quiescent B_J magnitude of approximately 16.5 ± 0.5 occurred at $8^h\ 36^m\ 30^s \pm 30^s$ LST on April 4th, 1984. It lasted for approximately 8 minutes by which time it had returned to within 0.3 mag of J = 16.5. The colour from the Palomar sky survey is consistent with that of a dM star.

$\alpha = 5^h\ 42^m\ 33.3^s$
$\delta = -20^\circ\ 05'\ 02.5''$
(1950.0)

A.R. GOOD

Royal Observatory, Blackford Hill
Edinburgh, EH9 3HJ, Scotland

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PHOTOMETRY OF THE ECLIPSING STAR W CRUCIS

In I.B.V.S. Number 2524, Plavec (1984) made an appeal to southern observers for photoelectric observations of the puzzling eclipsing star W Crucis. In particular an update of the ephemeris of the time of primary minimum is necessary to plan future ultraviolet spectrum observations during or near totality.

At Auckland Observatory we have been making three colour UBV observations since 1984 March 8 following a suggestion from E. Budding of the Carter Observatory Wellington who has been corresponding with Plavec. We have successfully covered one primary and one secondary minimum for which times and details are presented below.

The equipment used was the Mark I photometer on the Edith Winstone-Blackwell 50cm Cassegrain telescope, described previously (Walker and Marino, 1978).

Light and colour curves during the secondary minimum show considerable complexity, with asymmetry suggesting a multiple eclipsing object, for example, a star plus a circumstellar shell, accretion disk and/or obscuring clouds. Ingress was well advanced when observations started, but we were able to determine a mid-eclipse time for the V data of J.D. 2445795.45 ± $0^{d}.40$. If a circular orbit is assumed the ephemeris quoted by Plavec yields an O-C = +1.34 days.

Primary eclipse is more regular in V and B and does not appear to total in V. The U observations, however, show similar complexity and asymmetry to that found at secondary minimum. From the observations to this date we have determined a V mid-eclipse time of J.D. 2445894.08 ± $0^{d}.13$. This yields an O-C = $+0^{d}.70$.

The data are summarised in Figure 1 as light and colour curves plotted against phase using the ephemeris from Plavec (1984).

Observations are continuing and will be presented elsewhere in greater detail when the present observing season ends.

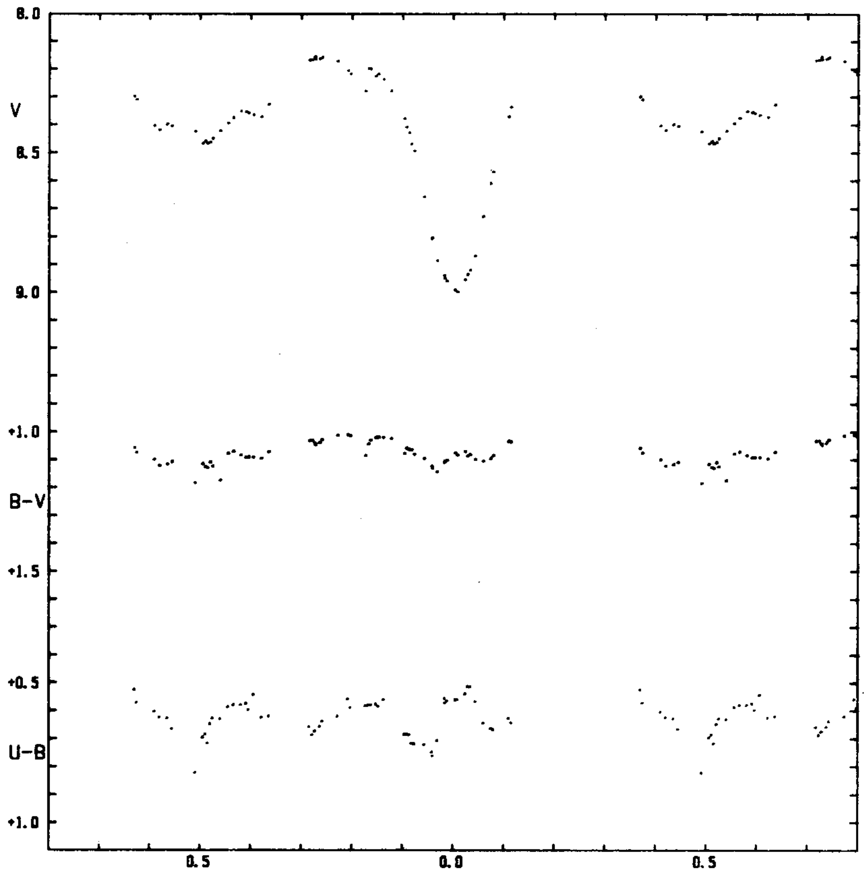

Figure 1. Three colour observations of W Crucis covering the interval JD 2445767 to JD 2445915. Phases are computed from

E = JD 2440731.6 + 198.53 d

BRIAN F. MARINO, W.S.G. WALKER and G. HERDMAN
Auckland Observatory of the Auckland Astronomical Society Inc.

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PHOTOGRAPHIC OBSERVATIONS OF NGC 2346 DURING 1983-84

We have previously reported photographic observations of the central star of NGC 2346 for the 1981-82 (Marino and Williams, 1983) and 1982-83 (Marino et al, 1984) observing seasons. Some of these magnitudes have been revised at fainter limits (Mendez et al., 1983) following receipt from R. Gathier of photoelectric V and B magnitudes for a number of the fainter field comparison stars around NGC 2346 (Marino et al., 1984A). Photography has been continued during the 1983-84 season just completed using the same equipment, observing methods and reduction techniques previously described, and the extended comparison star sequence.

We present in Table I a summary of the new photographic estimates. The phase positions have been calculated using the ephemeris E_n=2443126.0 + 15.991n (Mendez et al., 1982) determined from radial velocity observations before the beginning of the occultation.

In Table II we have summarised the observed maxima of magnitude 14.0 or brighter, and their phase positions, for the three observing seasons.

The 16 day periodicity observed in previous seasons is clearly seen occuring near phase 0.3 position. During the present season this continued until cycles 166-167 when a 1.5 cycle 'jump' appears to have occurred. The maximum following 166.3 occured at 167.8 and repeated on the succeeding cycles near phase 0.8. No maxima were observed at either 166.8 or 167.3. With succeeding cycles the maxima appear to be brightening and increasing in width.

Table I

Photographic observations of the central star of NGC 2346 between 1983 November and 1984 June

J.D. 2445000+		m_V	phase	J.D. 2445000+		m_V	phase
654.0		14.2	158.09	802.9		14.0	167.40
703.9		14.5	161.21	808.8		13.8	167.77
704.9		14.3	161.27	809.9		13.5	167.84
710.0		14.0	161.59	810.9	fainter than	14.0	167.90
727.8	fainter than	14.4	162.70	811.8	fainter than	14.4	167.96
741.9	fainter than	14.0	163.59	813.8	fainter than	14.2	168.08
746.9		14.5	163.90	814.8		14.2	168.14
749.9	fainter than	14.6	164.09	815.8	fainter than	14.2	168.21
750.9	fainter than	14.6	164.15	820.8	fainter than	14.4	168.52
752.9		14.2	164.27	830.8	fainter than	14.2	169.15
753.9		13.9	164.34	834.8	fainter than	14.4	169.40
754.8		14.0	164.39	836.8	fainter than	14.4	169.52
757.9	fainter than	14.4	164.59	837.8	fainter than	14.4	169.58
770.9		14.4	165.40	838.8	fainter than	14.4	169.65
771.9		14.5	165.46	840.8		13.2	169.77
773.9		14.0	165.59	841.8		13.1	169.83
774.9	fainter than	14.4	165.65	851.8	fainter than	14.4	170.46
785.9		13.6	166.34	852.8	fainter than	14.2	170.52
792.8	fainter than	14.4	166.77	858.8		13.4	170.90
801.8	fainter than	14.4	167.33	860.8		14.0	171.02

The data are consistent with the central binary star reappearing from the following edge of the obscuring dust cloud, or of the system becoming visible through a hole in the cloud as it moves across the system. If the former is the case then the earlier suppression of the light curve observed in 1982-83 can be expected to reverse during the coming season and the light curve return eventually to its former constant brightness of 11.2 magnitudes. If the latter is the case then complex changes of the light curve are to be expected as the hole passes across the central star.

Table II

Approximate times and phases of maxima 14.0 or brighter for the central star of NGC 2346

J.D. 2445000+	m_V	phase	comments
098.8	11.4	123.37	start of the 1981-82 season
114.8	11.4	124.37	
129.8	11.3	125.31	
337.9	12.6	138.32	start of the 1982-83 season
354.6	12.3	139.36	
384.9	13.0	141.26	
400.9	12.9	142.26	
414.8	14.0	143.13	max probably later and brighter
433.9	13.4	144.32	
753.9	13.9	164.34	start of 1983-84 season
785.9	13.6	166.34	
(792.8	inv<14.4	166.77)	transition from peaks at
(801.8	inv<14.4	167.34)	0.3 to 0.8 phase position
809.9	13.5	167.84	
841.8	13.1	169.83	
858.8	13.4	170.90	max probably earlier and brighter

No photoelectric observations were made during the season as the star was too low in the sky when it became sufficiently bright at maximum to be observed using the Auckland Observatory equipment.

BRIAN F. MARINO and H. O. WILLIAMS

Auckland Astronomical Society
P. O. Box 2858, Auckland 1
New Zealand

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o And. THE OVERALL BEHAVIOUR OF THE SHELL

The bright Be star o And (1 And, HR 8762, HD 217675 - 6, BD+41°4664, SAO 52609, IDS 23019 + 4219) has been observed for over 90 years. Throughout this period numerous observers detected highly variable spectrum, photometric changes and substantial range of radial velocity of this star. Much effort has been devoted to period searching in these data. In the present note the summary of the known history of the shell development is given.

Schmidt (1959) suggested that the shell of o And reappears with the period 31 years. This period was advocated by Pasinetti (1967, 1968), and once again, after the outburst in 1975, by Fracassini and Pasinetti (1975). In a detailed analysis based on critical evaluation of the homogeneous material Gulliver, Bolton and Poeckert (1980) have shown that the behaviour of the shell is far less orderly than described by previous authors and is probably non periodic.

Their conclusion is supported by the fact that another shell has been developed since the end of 1980 (Bossi et al., 1982, Baade et al., 1982). On the high-dispersion spectrogram taken February 1, 1983 by Dr. V. Umlenski with the 2m RCC telescope of the Rožen Observatory, Bulgaria, both hydrogen and metallic shell is clearly seen. Most of the lines show asymmetrical profiles. This finding was confirmed also by Barker (1984).

With the aid of published material and plates taken at Crimea Observatory by Dr. S. Kříž in 1965, by many observers at Ondřejov Observatory in 1968 - 1982 and by Dr. V. Umlenski at Rožen Observatory, the known history of the shell development can be summarized. This is depicted in Figure 1. Due to the limited size of the figure not all observations are included, but provisions were made to reproduce the shell behaviour of o And as reliably as possible. The shell strength is defined as in the paper by Gulliver et al. (1980): 0, normal B-type spectrum; 0.5, very weak hydrogen shell; 1.0 - 1.5, weak to moderate hydrogen shell; 2.0 , strong hydrogen shell (but no metallic lines); 2.5 - 3.0, weak to moderate metallic shell lines.

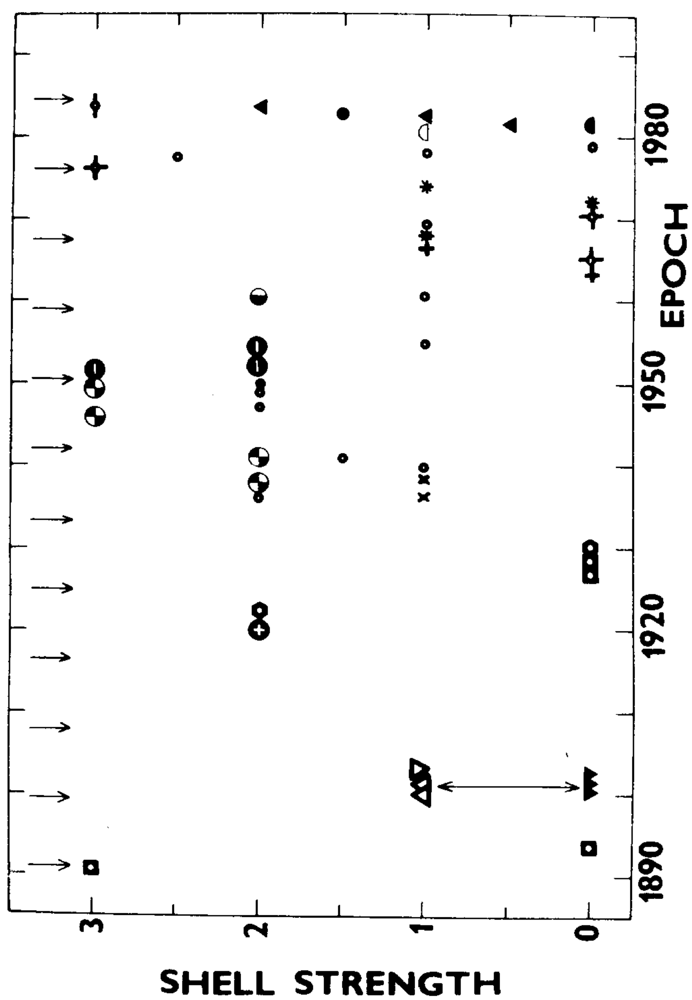

Figure 1. History of the shell development of o And. Following symbols are used:

▲ 1, ● 3, ▼ 4, ⬢ 5, ✱ 7, ◓ 8,

∘ 9, ⊕ 11, ▽ 13, ✚ 14, ⌓ 17, ◐ 18

◕ 20, ⊖ 21, ✗ 22, ▣ 23, △ 24,

✢ Crimea and Ondřejov Observatories, -o- Rožen Observatory.
The numbers are explained in the reference list.

Recently, Harmanec (1984) stressed the possible connection of the presence of the hydrogen shell and the orbital motion of the closer visual companion to o And. He disclosed that the recorded hydrogen-shell episodes seem to occur with the 3100-day periodicity and he stated that the observed angular separation of the pair and the parallax of o And are in excellent agreement with a similar (8.5 years) period.

This period is indicated by arrows in the upper part of Figure 1. It is readily seen that the behaviour of the hydrogen shell is too complicated to be expressed by simple periodic process.

The hydrogen shell of o And is the subject of the variability on even shorter time-scale than mentioned so far. To give few examples Gulliver et al. (1980) noted temporary increase of shell strength from November 1976 to January 1977; Poeckert and Gulliver (1980) and Gulliver (1980) reported a short-lived hydrogen shell from May 1980 to August 1980. Also variations on day time-scale are definitely present (Gulliver et al., 1980, Hubert-Delplace and Hubert, 1979). The overall picture is also influenced by the inaccurate description of the old spectra. Note the difference of the description of the same spectrograms by Wright (1902) and Campbell (1928) depicted by the abscissa in the lower part of Fig. 1.

It seems that the period proposed by Harmanec (1984) is in better agreement with metallic-shell events (4 coincidences, in 5 cases the observations are not available, in 3 cases the metallic shell was not observed). One should try to find more archival plates in order to have the recorded history of o And as complete as possible. This would help to solve the puzzle of o And.

PAVEL KOUBSKÝ

Astronomical Institute
Czechoslovak Academy of Sciences
251 65 Ondřejov, Czechoslovakia

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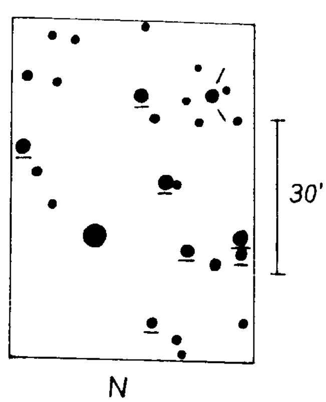
NOVA V 906 OPHIUCHI REDISCUSSED

By a letter of Dr. N. Samus', Astronomical Council of the USSR, our attention was directed to the insufficient map of the surroundings of V 906 Oph published in Mitt. Veränderl. Sterne, 2, p.166. Below a better chart is given. We add a complete list of the, partially revised, estimates on all patrol exposures available at Sonneberg. The near-edge distortion of the image of the nova on the plates makes a linking of the comparison stars to a standard field impossible. Instead, HD ptg. magnitudes of the stars underlined in the map were directly used.

J.D. 243...	m_{pg}
4237.31	$>11^m.3$
39.41	9.8
40.31	9.3
41.30	9.6
42.40	10.1
44.32	9.9
44.39	9.9
45.40	10.0:
46.28	10.4
46.43	9.9
48.29	$\geq$10.1
48.44	10.0
50.40	10.3
62.28	11.5
64.34	11.0:
69.39	>11.8



Probably the nova has been catched on its rise at 4239.41. The quiescent state may easily be near $B = 20^m$.

W. WENZEL

Sternwarte Sonneberg
Zentralinstitut für
Astrophysik der Akademie
der Wissenschaften der DDR

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NEW VARIABLES IN M 80

To continue an investigation of Messier 80 (NGC 6093, C1614-228) begun many years ago (Sawyer, 1942) a new series of plates was taken from 1972 to 1983 with the 60 cm telescope of the University of Toronto at Las Campanas, Chile. Using the blink comparator of the University of Western Ontario three new variables in the cluster have been discovered on these plates.

Table I lists the coordinates and magnitude ranges for these new variables, numbers 8, 9, and 10. In addition, data are listed for the W Virginis star, variable 1, in order to correct an error of one digit in the y coordinate as given in Sawyer Hogg's Second and Third Catalogues of Variable Stars in Globular Clusters (1955, 1973). Magnitudes are based on the sequence of Harris and Racine (1974) but because variables 8, 9 and 10 are closer to the cluster centre their magnitudes may be too bright.

Table I

Variable	x"	y"	B_{max}	B_{min}
1	-137	+79	13.7	15.1
8	- 24	+17	14.6	16.1
9	+ 16	+36	15.3	16.4
10	- 19	+ 1	14.4	15.4

Since variable 6, S Sco, and variable 7, R Sco, are field stars, the total number of variables now thought to be members of the cluster is eight, in addition to the nova, T Sco, seen visually in 1860.

At the present time the plates are in the process of measurement with the iris photometer of the University of Western Ontario and it is planned to discuss the magnitudes, periods and light curves of all ten variables in a later paper. With a series of plates taken in 1939 with the 90 cm telescope of the University of Arizona and three other series of University of Toronto plates beginning in 1946, our observations now extend over four decades into 1983. This should enable us to discuss the long term behaviour of the variables.

AMELIA WEHLAU, PAUL CANNON and PHILIP RICE

Department of Astronomy
The University of Western Ontario
London, Canada N6A 3K7

HELEN SAWYER HOGG

David Dunlap Observatory
University of Toronto
Richmond Hill, Ontario, Canada L4C 4Y6

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INFORMATION ON SIX NOVAE IN SAGITTARIUS

In a project to locate several novae in Sagittarius for Dr. Hilmar W. Duerbeck of the Observatorium Hoher List of Bonn University, I collected data on five novae and present precise coordinates for each, photographic magnitudes for each (Table I), finding charts of those for which no finding chart is available, and some comments on each one. In addition, I enclose a note on V1944 Sgr.

Duerbeck (1984) is planning to publish a catalog which will include data on about 250 galactic novae.

V3645 Sgr

This was discovered on July 29, 1970 on an objective prism plate by Arhipova and Dokuchaeva (1970). A finding chart (with sequence stars) was published by Arhipova, et al (1971). The precise coordinates of V3645 as measured here at the Maria Mitchell Observatory are $18^h\ 32^m\ 53^s.39\ \pm 0^s.02$ and $-18^\circ\ 44'\ 25''.7$ $\pm 2''.1$, epoch 1950. Magnitude estimates are provided.

V3889 Sgr

This was discovered by Kuwano (1975) on July 13, 1975. A plate was taken here at Maria Mitchell especially for this nova. The precise coordinates are $17^h\ 55^m\ 11^s.55\ \pm 0^s.10$ and $-28^\circ\ 21'\ 34''.9\ \pm 3''.3$, epoch 1950. A finding chart and magnitude estimates are provided.

V4021 Sgr

This was also discovered by Kuwano (1977) but on March 27, 1977. It is just to the northeast of the globular cluster M22 at $18^h\ 35^m\ 11^s.45\ \pm 0^s.15$ and $-23^\circ\ 25'\ 35''.5\ \pm 1''.2$, epoch 1950. A finding chart and magnitude estimates are provided.

V4027 Sgr

This was discovered by MacConnell (1968) on an objective prism plate taken May 17, 1968. The coordinates as published by MacConnell are $17^h\ 59^m\ 18^s.87$ and $-28^\circ\ 45'\ 23''.8$, epoch 1950. A finding chart and magnitude estimates are provided.

Nova Sgr 1982

This was discovered by Honda (1982) on October 4, 1982. The coordinates as measured by Flynn and communicated by Candy (1982) are $18^h\ 31^m\ 32^s.75$ and $-26^\circ\ 28'\ 28''.0$. There is a preliminary finding chart published by the AAVSO, but I have provided one that is more detailed. Magnitude estimates are also provided.

Note on V1944 Sgr

This was discovered by Apriamashvili (1960) at a magnitude of 13.0 on an objective prism plate taken May 24, 1960. No epoch was given for the coordinates published by Apriamashvili. However, It seems that the only way to reconcile the coordinates published by Apriamashvili and those published by Kukarkin et al (1970) is to assume that the epoch of those quoted by Apriamashvili is 1960. With this in mind then, I located the exact position of the nova on a photographic plate taken on June 16, 1960, 23 days after the nova's discovery. It appears that the area where V1944 should be is a very crowded star field and indications are that the image of V1944 is either partially or completely merged with one or more of the field stars. Unfortunately, the field of V1944 is near the edge of all the plates taken in June and July of 1960; as a result, the stars suffer significantly from the effects of coma. Even using the blink comparator technique of field comparison, no part of the blend of the images can be unambiguously ascribed to V1944 Sgr.

The area examined in the blink comparator included the region where the nova would have been if the epoch of Apriamashvili's coordinates had been 1900 or 1950. Nothing positive was discovered at these two locations either.

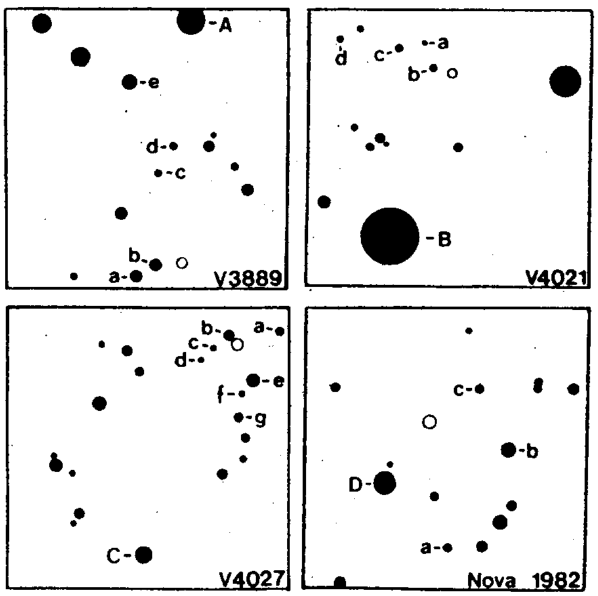

Fig. 1: Finding charts for the four novae in Sagittarius. Each chart is 15' by 15' with north at the top and west to the right. The lower case letters denote sequence stars whose photographic magnitudes are given in Table II. The capital letters denote SAO stars: A=SAO186010, B=SAO187080, C=SAO186160 and D=SAO187001.

Table I: Photographic magnitudes for the five novae. The dates in the table are JD-2400000. A left parenthesis means "fainter than".

<u>V3645 Sgr</u>

40418	(15.5	40735	14.7:
40474	13.6	40737	14.8::
40476	13.6	40746	15.0::
40477	13.6	40767	15.0::
40479	13.5	40799	15.1::
40493	13.4	40803	15.6::
40495	13.4	40806	15.6::

Table I : continued

V3889 Sgr

42327	(14.4
42542	(13.0::
42623	12.0
42634	12.7
42934	15.0::
43044	(14.4

V4021 Sgr

43044	(14.8:
43047	(14.3
43308	11.4
43314	11.7
43318	11.7
43340	11.8
43375	11.9
43417	12.0
43690	(14.5

V4027 Sgr

39761	(14.6
40002	12.0
40003	12.0
40004	12.1
40028	14.1
40039	14.0:
40058	14.0:
40059	14.2:
40064	14.1:
40067	14.2
40068	14.2:
40084	14.2:
40087	14.1:
40092	14.2:
40114	14.3:
40120	14.2:
40382	14.6:
40417	14.9:

Nova Sgr 1982

44510	14.3
44525	14.3
44757	14.2:
44782	14.3
44813	14.4:
44837	14.3:
45084	14.3
45144	14.2
45177	14.3
45223	(14.1
45232	9.6
45523	12.9
45549	12.9
45584	13.1
45602	13.2
45616	13.2
45879	14.1:
45902	14.1:
45913	14.0:
45930	14.1:
45934	14.2

Table II: This table lists the photographic magnitudes for each of the sequence stars in the four finding charts.

Sequence stars	V3889	V4021	V4027	Nova 1982
D	---	---	---	9.1
a	11.5	14.2	12.7	13.1
b	11.1	12.1	11.9	11.7
c	13.2	12.7	14.2	12.8
d	12.7	13.3	13.8	---
e	11.8	---	10.9	---
f	---	---	13.0	---
g	---	---	12.3	---

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ATAOLLAH SARAJEDINI
Maria Mitchell Obs.
Nantucket, Mass. 02554
U. S. A.

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THE PHOTOMETRIC VARIABILITY OF EPSILON PERSEI

Epsilon Persei (HR 1220, HD 24760, B0.7III (or B0.5V), V = 2.88) has a long history of suspected light, radial velocity, and line profile variations (reviewed by Smith 1984) going back to the beginning of this century. Our own interest in this star arose from the photographic spectroscopic studies of Bolton, Lane and Thomson at this Observatory; they showed that this star exhibits striking line profile variations, with as many as four components moving through the line profile on a time scale of a few hours. More recently, Smith (1984), Penrod and others have recorded the line profile variations of this star with modern high-dispersion, high signal-to-noise spectroscopic detector systems. They have found that it is possible to model these variations with a combination of prograde sectorial non-radial pulsation modes. Our previously-unpublished 1979 and 1980 photometric observations give some indication of the nature of the photometric variability of this star, and place some constraints on the pulsation modes which may be present.

Photometric observations were made by one of us (JRP) on five nights in November 1979 and on seven nights in November 1980 using the #4 0.4 m telescope at the Kitt Peak National Observatory in Arizona. A 1P21 photomultiplier and pulse-counting electronics were used, along with a three-magnitude neutral density filter to reduce the coincidence counting effects. Measurements were made through a standard Strömgren b filter, differentially with respect to the stars HR 1229 (A1, V = 6.2) and HR 1234 (B9.5, V = 6.3). Magnitude differences were corrected for differential extinction effects, and times were reduced to the sun. The magnitude differences, on the instrumental system, are shown in Figure 1. A table of these data may be obtained from author JRP if necessary. The standard deviation of the magnitude differences between the comparison stars was $0\overset{m}{.}004$.

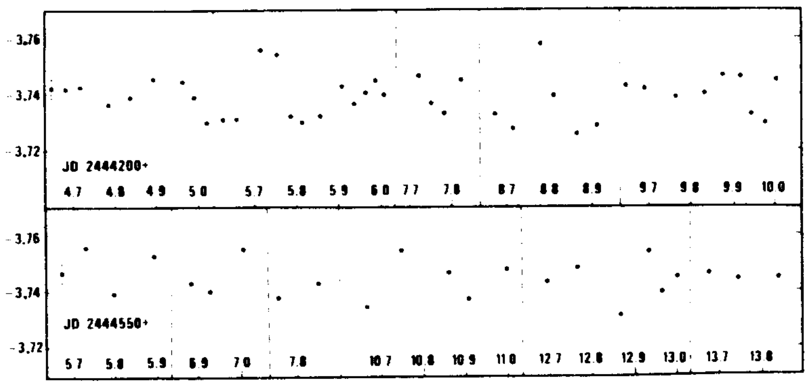

Figure 1 – Photometric (b) observations of ε Persei relative to HR 1229. The constancy of HR 1229 was established relative to HR 1234. The error bars indicate the standard error of a single observation. The program star exhibits small but significant variability from hour to hour, but not from night to night or season to season.

The main results of our photometric observations are as follows:

1. The scatter in the magnitude differences between ε Persei and HR 1229 is considerably greater ($\sigma = 0^{m}.0074$) than that between HR 1229 and HR 1234 ($\sigma = 0^{m}.004$) whereas the reverse might be expected since the former two stars are brighter and closer together in the sky. This suggests that ε Persei is variable with a σ of about $0^{m}.006$, which corresponds to a peak-to-peak amplitude of about $0^{m}.02$ on the average.

2. The variations appear to take place on a time scale of hours. The variations from night to night, and between the 1979 and 1980 runs, do not exceed $0^{m}.01$ in b.

3. Period analysis of the 1979 observations, using the methods of Scargle (1982) and Stellingwerf (1978), show a peak at a period of about 0.216 day. The statistical significance of this peak is 0.87 (the probability that it is not due to chance), which is suggestive but not convincing. The power spectrum of the less numerous 1980 observations also shows a peak at this period, but with an even lower significance.

4. Even after the removal of these peaks, there is a residual variance of about $0^{m}.01$. This suggests that two or more modes may be present (or that the variability may be irregular).

It is not possible to draw any firm conclusions from our observations, because of their limited number, and because of the lack of simultaneous spectroscopic observations. In November of this year, we plan to obtain many more observations, and Myron A. Smith plans to obtain simultaneous spectroscopic observations. We encourage other observers to obtain careful photometric observations of this interesting star.

We thank Tom Bolton, Petr Harmanec, Don Penrod and Myron Smith for sharing unpublished data and for interesting and useful discussions. We also thank the Kitt Peak National Observatory for allocations of observing time, and the Natural Sciences and Engineering Research Council of Canada for an operating grant.

JOHN R. PERCY, MICHAEL BIETENHOLZ
and ALEX FULLERTON

David Dunlap Observatory,
University of Toronto,
Toronto, Canada M5S 1A1

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NEW PHOTOMETRY OF THE ECLIPSING BINARY 5 CETI

Discovery of the variability of 5 Ceti (actually in the constellation Pisces, also known as HR 14), based on V-band photometry in 1979 and 1980, was reported by Lines and Hall (1981). In this note we present additional photometry obtained in 1981 and 1983/84 and make all the data available to others who may wish to solve the light curve of this interesting late-type apparently contact eclipsing binary with an orbital period of almost 100 days.

In 1981 Lines used the same telescope to observe in V of the UBV system on 46 nights between JD 2444803.95 and 2444928.68, again using 29 Psc as the comparison star. Nightly means are plotted in Figure 1, where phase has been computed with the ephemeris given by Lines and Hall (1981). Nightly means of these 1981 data and the (not previously published) 1979 and 1980 data are tabulated in Tables I and II.

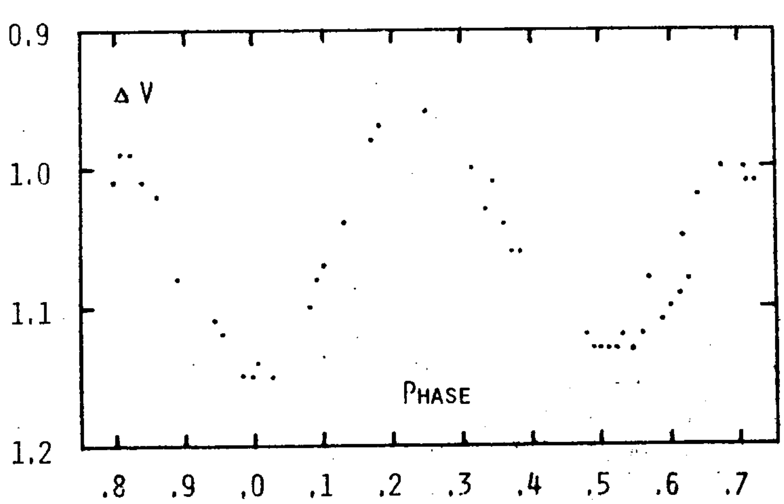

Figure 1

The 1981 light curve of Lines discussed in the text. In two instances, in secondary minimum, points overlap and cannot be distinguished.

Table I

Photometry of 5 Ceti for 1979 and 1980

JD 2,444,000	ΔV	JD 2,444,000	ΔV	JD 2,444,000	ΔV
138.78	1.07	445.92	0.96	523.74	1.09
139.78	1.06	455.91	1.07	530.74	1.01
158.78	0.99	457.89	1.12	531.75	1.02
159.75	1.00	458.90	1.11	532.74	1.00
162.75	1.03	459.90	1.13	535.73	0.97
168.72	1.12	460.92	1.15	536.72	0.97
171.70	1.15	462.91	1.17	537.72	0.99
174.69	1.16	467.92	1.18	539.69	0.98
175.67	1.19	468.89	1.16	541.71	0.98
177.68	1.18	470.87	1.14	542.71	0.98
178.67	1.17	473.86	1.10	543.69	0.99
186.65	1.06	482.86	0.98	557.68	1.16
187.68	1.04	483.85	0.98	559.66	1.16
190.66	0.99	485.86	0.96	560.64	1.16
191.69	1.00	489.88	0.95	562.64	1.18
193.75	0.98	493.85	0.99	563.65	1.17
194.64	0.97	502.78	1.06		
201.63	0.95	509.81	1.13		
202.65	0.97	510.81	1.12		
203.60	0.97	511.79	1.13		
204.62	0.99	512.77	1.12		
214.62	1.08	513.78	1.13		
215.62	1.08	514.76	1.13		
217.65	1.09	515.75	1.13		
218.59	1.12	516.74	1.13		
220.60	1.11	517.75	1.13		
221.64	1.12	518.74	1.13		
222.61	1.13	519.73	1.12		
		521.74	1.11		
		522.74	1.10		

Table II

Photometry of 5 Ceti for 1981

JD 2,444,000	ΔV	JD 2,444,000	ΔV
803.95	1.13	868.81	0.97
804.94	1.13	875.79	0.96
805.95	1.12	881.78	1.00
808.96	1.12	883.73	1.03
809.94	1.08	884.77	1.01
814.95	1.05	885.76	1.04
816.95	1.02	886.75	1.06
819.95	1.00	887.75	1.06
822.90	1.00	897.75	1.12
832.92	0.99	898.73	1.13
833.93	0.99	899.72	1.13
835.91	1.01	900.72	1.13
837.88	1.02	901.71	1.13
840.88	1.08	903.70	1.13
845.89	1.11	908.69	1.11
846.89	1.12	909.69	1.10
849.87	1.15	910.72	1.09
850.86	1.15	911.69	1.08
851.89	1.14	919.67	1.01
853.81	1.15	920.66	1.01
858.85	1.10	928.68	1.01
859.85	1.08		
860.84	1.07		
863.83	1.04		
867.82	0.98		

In the last quarter of 1983 and the first quarter of 1984 Boyd observed in the UBV system on 32 nights between JD 2445621.79 and 2445710.6, using the automatic photoelectric telescope described by Boyd, Genet, and Hall (1984a) and HD 315 as the comparison star. Although not plotted here, the data have been discussed by Boyd, Genet, and Hall (1984bc) and have been sent to the I.A.U. Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1982) where they are contained in files no. 131 and no. 136.

From this collection of data we can estimate three times of mid primary eclipse. From the combined 1979 and 1980 data we used the Pogson method to get JD 2444176.5 ± $0^d.2$; this time was taken as the initial epoch of the ephemeris given by Lines and Hall (1981). From the 1981 data we again used the Pogson method to get JD 2444851.5 ± $0^d.5$. From the 1983/84 data we have only one observation near primary minimum, JD 2445621.8, which could be uncertain by roughly one day. The most recent two times give O-C residuals which are consistent with their uncertainties, indicating that a refinement of the $96^d.41$ period is not necessary at this time.

RICHARD D. LINES

6030 North 17th Place
Phoenix, Arizona 85016

LOUIS J. BOYD

Fairborn Observatory West
629 North 30th Street
Phoenix, Arizona 85008

RUSSELL M. GENET

Fairborn Observatory East
1247 Folk Road
Fairborn, Ohio 45324

DOUGLAS S. HALL

Dyer Observatory
Vanderbilt University
Nashville, Tennessee 37235

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UBV PHOTOMETRY FOR BD $+37^{\circ}$ 2356

The variable star BD $+37^{\circ}$ 2356, classified as W UMa type variable star by Zhukov (1982), was observed in March and May 1984 using UBV photometer attached to the 91 cm reflector at McDonald Observatory. Same comparison star (HD 113 730 = BD $+37^{\circ}$ 2360) with Zhukov's was used and about 300 observations in U, B and V bands were taken for the program star.

Six moments of minima were determined, their JD(hel) are as follows:

2 445 769.7314 (II), 2 445 770.6919 (I), 2 445 770.8840 (II),
2 445 773.7655 (I), 2 445 773.9575 (II), 2 445 841.7710 (I)

The new epoch of the primary minimum and the orbital period are:

$$JD(hel) = 2\,445\,841.7710\ (\pm 0.0003) + 0^{d}.384\,2105\ (\pm 0.000\,0001)E$$

The new period is a little longer than $0^{d}.38416$ given by Zhukov.

The light curve of V magnitude is shown in Figure 1. The eclipse depths at primary and secondary minima are almost equal. $V_{max} = 10^{m}.228\ (\pm\ 0^{m}.008)$, $V_{min} = 10^{m}.689\ (\pm\ 0^{m}.008)$. The colour indexes, shown in Figure 2 and Figure 3,

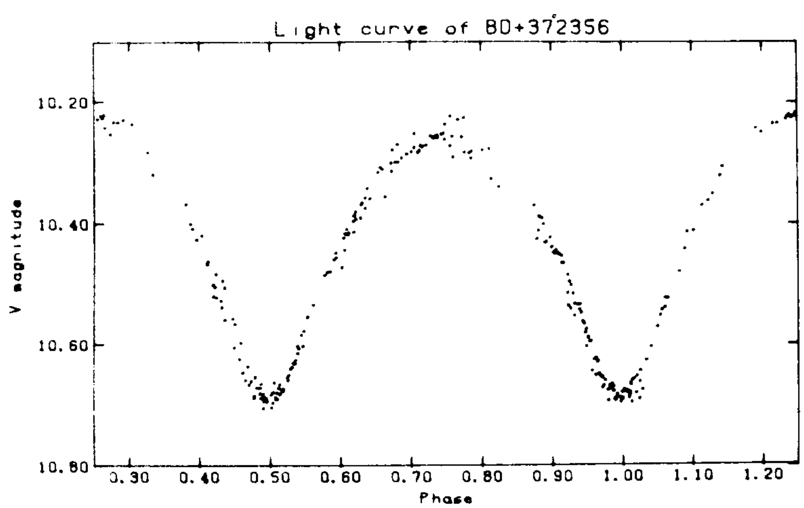

Figure 1

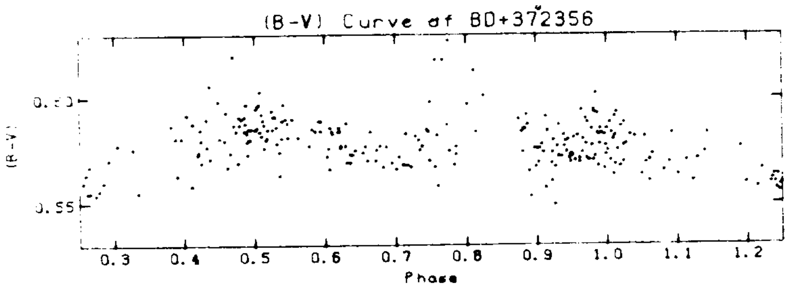

Figure 2

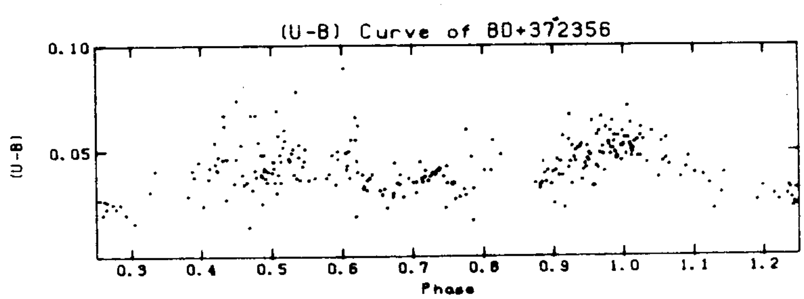

Figure 3

vary lightly with phase. The average colour indexes are:

$$\overline{(B-V)} = 0^{m}\!.578 \quad , \quad \overline{(U-B)} = 0^{m}\!.045 \quad .$$

LIU XUEFU and TAN HUISONG

McDonald Observatory
The University of Texas
(visiting scholars from China)

Reference:

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THE PERIOD AND PHOTOELECTRIC LIGHT CURVES OF DM Del

DM Del = BD+13° 4478 was discovered as an Algol type eclipsing binary by Hoffmeister (1935). Tsesevich (1954) obtained the following light elements from his visual observations:

$$\text{Hel.Min. JD} = 24\ 30\ 663.067 + 0^{\text{d}}.84456 \times E \quad .$$

Perova (1952) gave the corrected light elements as follows:

$$\text{Hel.Min. JD} = 24\ 30\ 663.067 + 0^{\text{d}}.8446725 \times E \quad .$$

Ishtshenko (1955) confirmed the above Perova's elements and classified the light curve of the system as β Lyrae. Schneller (1960) observed DM Del photoelectrically in one colour and analyzed his light curve. Diethelm (1976) gave the period of $0^{\text{d}}.333042$ from the visual observations. But several observers showed that this period was not correct. Berthold (1978) observed the system visually and photographically and gave the following light elements:

$$\text{Hel.Min. JD} = 24\ 42\ 685.302 + 0^{\text{d}}.8446733 \times E \quad .$$

According to his photographic light curve, the depths of the minima are approximately equal.

In order to check the period of DM Del, we observed it photoelectrically during the observational seasons of 1982 and 1983 in 12 different nights. The observations were made with the 48 cm Cassegrain reflector equipped with an unrefrigerated EMI 9781A photomultiplier tube and with B,V filters very close to Johnson's system. BD+14° 4379 was used as comparison star. Three primary and four secondary times of minima were obtained . These minima are given in Table I where $O-C_1$ residuals are computed with the elements in GCVS (1969). It is seen that all $O-C_1$ values are large and positive. Therefore, using these photoelectric minima given in Table I and the photoelectric minimum time of Schneller, the new light elements were calculated by the method of weighted least squares as follows:

$$\text{Hel.Min.JD} = 24\ 45\ 523.43\underset{\pm 9}{68} + 0^{\text{d}}.84467\underset{\pm 3}{47} \times E \quad .$$

Table I. The times of minima of DM Del

Hel.Min. JD	Min.	Filter	$O-C_1$	$O-C_2$
24 45 194.4394	II	B,V	0.0491	0.0034
200.345	II	B,V	0.042	-0.004
219.3558	I	B,V	0.0476	0.0019
523.4355	I	B,V	0.0452	-0.0013
605.3694	I	B,V	0.0459	-0.0008
613.396	II	B,V	0.048	0.001
619.3059	II	B,V	0.0453	-0.0014

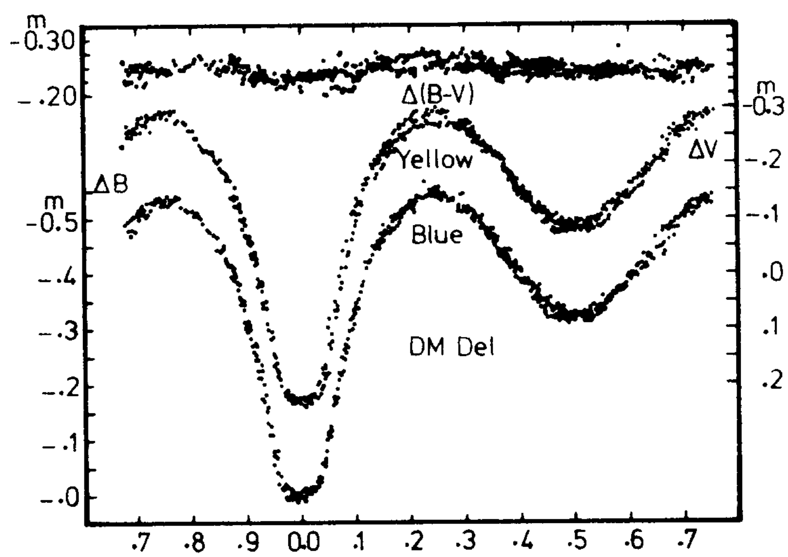

Figure 1. Light and colour curves of DM Del

The light and colour curves are presented in Figure 1 where the individual magnitude differences (variable minus comparison) have been plotted against the phases. The phases in the figure and $O-C_2$ values in Table I were calculated with the new light elements. The light curves show that DM Del is a typical β Lyrae type eclipsing binary. The system varies about $0^m.540$ and $0^m.510$ at the primary, $0^m.220$ and $0^m.200$ at the secondary minimum in blue and yellow light, respectively. The colour curve shows that there is a noticeable colour variation at the primary minimum.

N. GÜDÜR, C. SEZER, Ö. GÜLMEN

Ege University Observatory
Bornova, Izmir, Turkey

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TWO NEW VARIABLE STARS NEAR CHI URSAE MAJORIS

Ten pairs of B plates taken with the 67 cm Schmidt telescope of Asiago Observatory in the field around χ Ursae Majoris have been compared with the stereoscopic method and two new variable stars (not listed in the General Catalogue of Variable Stars and Supplements and in the Catalogue of Suspected Variable Stars) have been discovered.

The material examined (54 plates) cover the period between January 1966 and December 1982. On the basis of our observations it is not possible to derive the elements of these variables.

The position (1950) and the characteristics of these stars are:

GR 313	RA = $11^h53^m06^s$,	D = $+49^{\circ}11'.0$	max=15.9, min=17.5, type=RR Lyr
GR 314	RA = $11^h54^m34^s$,	D = $+48^{\circ}45'.0$	max=16.4, min=17.7, type=RR Lyr.

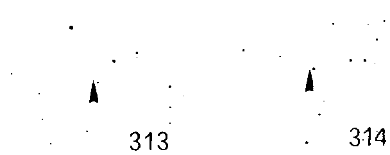

Figure 1

Figure 1 shows the identification chart (B light) of GR 313 and GR 314. The side is 15' .

G. ROMANO
Instituto di Astronomia
Università di Padova
Padova, Italy

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FIVE COLOUR PHOTOMETRY OF THE CHROMOSPHERICALLY ACTIVE SOUTHERN STAR HD 155 555*

HD 155 555 was found by Bennett et al. (1962) to be a double line spectroscopic binary with an orbital period $P_o = 1^d.6817$. The components seem to have similar mass. Optical and IUE spectra show strong Ca II H and K and Mg II h and k emission coming from both components of the system (Stacy et al., 1980). The Hα emission fills entirely the relevant absorption line (Hearnshaw, 1979). The spectral type of HD 155 555 is G5 IV + K0 or K1 Vp according to Bennett et al. (1962) or Houk and Cowley (1975), respectively. HD 155 555 is also a soft X-ray source (Walter et al., 1980). In spite of its relatively large apparent visual brightness ($V \sim 6^m.7$) very few photometric observations of the star have been obtained up to now: Eggen (1978) reported two measurements and cited another one suspecting the star's variability. The confirmation of the optical variability of HD 155 555 was independently found by Collier (1982) and by Udalski and Geyer (1984). We give in this short communication more details about the complete light and colour curves.

UBVRI observations of HD 155 555 were collected at the European Southern Observatory / La Silla during 12 consecutive nights from April 13, 1984 on. The 50 cm ESO telescope equipped with a single beam photometer and an RCA 31034 thermoelectrically cooled gallium-arsenide photomultiplier was used. The standard UBVRI system was reproduced by the relevant colour filters as described by Bessell (1979). HD 156 427 served as primary and HD 154 775 as a secondary comparison star. Both comparison stars were constant during the observations. The observations of HD 155 555 were made differentially in the usual way. The magnitude differences were corrected for differential extinction and transformed to the standard UBVRI system, after having established the transformation equations from the instrumental into the standard system by observing more than 30 UBVRI standard stars on 9 nights of high photometric quality. The standard errors of one single observation turned out to be

* Based on observations obtained at the European Southern Observatory, La Silla, Chile.

$0^{m}.015$, $0^{m}.008$, $0^{m}.007$, $0^{m}.006$, and $0^{m}.005$ in the U, B, V, R, and I colour bands, respectively. The results obtained for the colours and magnitudes of the comparison stars are summarized in Table I.

Table I. Magnitude and colours of the comparison stars for HD 155 555

Star	V	B–V	U–B	V–R	V–I
HD 156 427	$7^{m}.395$	$1^{m}.494$	$1^{m}.656$	$0^{m}.805$	$1^{m}.543$
m.e.	.011	.007	.017	.006	.006
HD 154 775	7.589	1.587	1.962	0.865	1.744
m.e.	.013	.010	.029	.006	.005

After a few nights of observations it was realized that HD 155 555 is photometrically variable and the period of its brightness variations is close to the orbital one. We determined the photometric period P_p of HD 155 555 using the "phase dispersion minimization" (PDM) method described by Stellingwerf (1978). The PDM-analysis yielded $P_p = 1^{d}.66$. It seems to be somewhat smaller than the orbital period ($P_o = 1^{d}.68$). As the observational run was not long enough, the PDM-method gives an accuracy of about 7% for the period determination. Hence the difference found between P_p and P_o is not significant statistically. Therefore, synchronization of rotation with orbital revolution seems to be fulfilled for the system, if we suppose that the photometric variations are caused by the rotation of the G5 component with unequal brightness distribution on its photosphere. In order to determine the periods more precisely, additional photometric and spectroscopic rv-observations are necessary.

Figure 1 shows the light and colour curves of HD 155 555 based on the elements:

$$\text{Min. (J.D.hel.)} = 2445803.07 + 1^{d}.66 \cdot E$$

The shown magnitude differences have the sense 'variable minus comparison'. The shape of the V light curve is completely symmetrical and sinusoidal with an amplitude of $0^{m}.08$. The colour changes are noticeable only in the (V–I)-index and the star is redder near the minimum light.

We tend to interpret this small amplitude light and colour variation to be caused by the rotation of the chromospheric active G5-component with subluminous photospheric areas. The reasons for this interpretation are threefold. Firstly, the coincidence of the light curve minimum with that of the (V–I)-curve is typical for chromospheric active stars. Secondly, the large scatter of the (U–B)-colour curve indicates that chromospheric calcium 'plages' are appearing and/or disappearing at the limb of the stellar disc.

HD 155555

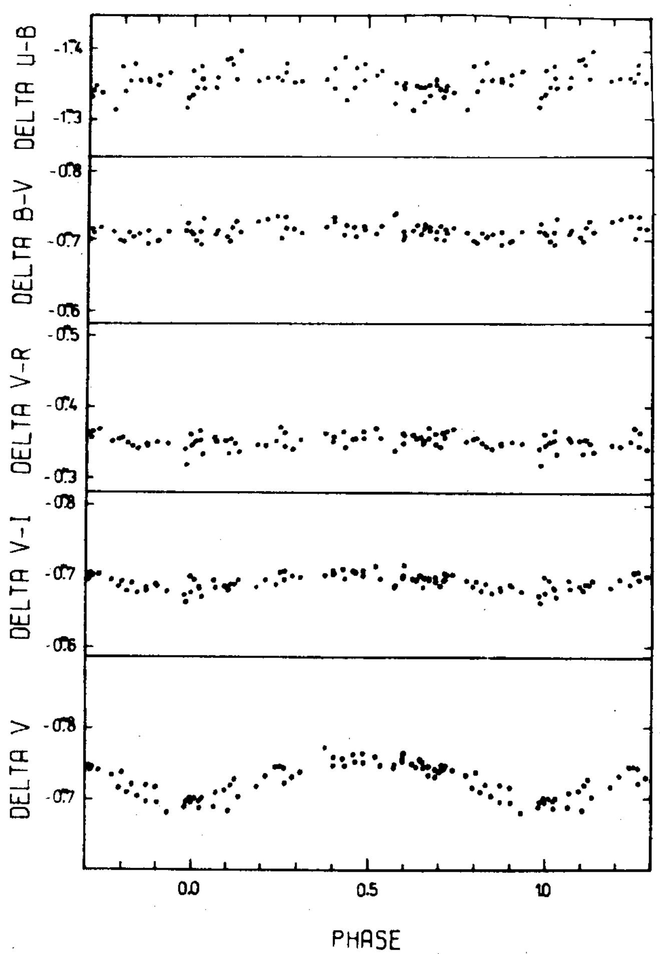

Figure 1

Table II. The average colours and V magnitudes of HD 155 555 and the observed light and colour curve amplitudes in 1984

V	A_V	B–V	A_{B-V}	U–B	A_{U-B}	V–R	A_{V-R}	V–I	A_{V-I}
$6^m.67$	$0^m.08$	$0^m.78$	-	$0^m.30$	-	$0^m.45$	-	$0^m.85$	$0^m.04$

Table III. Minimum and maximum time instants of the 1984 light curve of HD 155 555 in J.D.hel.

Min.	Max.
2445804.73	2445808.85
2445809.71	2445813.83

Finally, comparing the average V-magnitude and colours of HD 155 555 listed in Table II, with those cited by Eggen (1978) and Collier (1982) we find indications of changes on a time scale of several years: at the beginning of the 1960's the V-magnitude and the (B–V)-colour of HD 155 555 were similar to the present one, while in 1973 the star was about $0^m.1$ fainter in V and the (B–V)-colour was larger by $0^m.05$. Again, in the late 1970's the colour and light curve amplitudes were almost identical with those of 1984, though the system brightness remained $0^m.1$ fainter.

As was shown long ago by Russell (1906) a great variety of distribution of brightness on a rotating sphere may give rise to the same light curve, this model of a chromospherical active component in the HD 155 555 binary system can fully explain the photometric phenomenology. Since also the spectroscopic properties are similar to the RS CVn variables, HD 155 555 can be considered as a typical member of this class.

A. UDALSKI[1,2] and E.H. GEYER[2]

[1]Warsaw University Observatory
Al. Ujazdowskie 4
00-478 Warszawa, Poland

[2]Observatorium Hoher List
der Universitäts-Sternwarte Bonn
D - 5568 Daun, F.R. Germany

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THE LIGHT AND COLOUR CURVES OF THE VERY ACTIVE SOUTHERN RS CVn-SYSTEM HD 127 535 IN 1984*

HD 127 535 was classified as a southern RS CVn candidate by Weiler and Stencel (1979) on account of the strong Ca II H and K emission in the spectra of this object. Collier et al. (1982) found also Hα in emission. Furthermore, Collier (1982) reported radial velocity variations with a period of $6^{d}.01$ confirming the spectroscopic binary nature. The spectral type of the system is K2 IV/Ve according to Houk and Cowley (1975). Photometric variability of HD 127 535 was discovered by Collier (1982) and independently by Udalski and Geyer (1984). In this paper we present the light and colour curves of this star observed in 1984.

UBVRI photometry of HD 127 535 was carried out at the European Southern Observatory / La Silla during 12 consecutive nights from 1984 April 13 on. The observations were obtained using the ESO 50 cm telescope with a single beam photometer equipped with a thermoelectrically cooled gallium-arsenide RCA 31034 photomultiplier. The pulse counting technique and UBVRI filters approximating the Cousins / Bessel system (Bessel, 1979) were used. HD 128 227 served as a primary comparison and HD 128 618 as a check supplementary star. The magnitude differences of these comparison stars were constant within $0^{m}.01$ in all colours during the total observational run. On 9 nights under the best sky conditions the transformation equations from the instrumental colour and magnitude system into the standard UBVRI system were obtained by observing more than 30 standard stars. The UBVRI magnitudes of the comparison stars are listed in Table I. Observations of HD 127 535 were made differentially in the usual way and corrected for differential extinction. The standard errors for the individual observations in UBVRI colour bands are $0^{m}.015$, $0^{m}.008$, $0^{m}.007$, $0^{m}.006$, and $0^{m}.005$, respectively. They are due to the combined errors of the observations and those of the transformation equations into the standard system.

* Based on observations collected at the European Southern Observatory, La Silla, Chile.

Table I. Magnitudes and colours of the comparison stars for HD 127 535

Star	V	B−V	U−B	V−R	V−I
HD 128 227	$8^{m}.321$	$1^{m}.066$	$0^{m}.810$	$0^{m}.570$	$1^{m}.095$
m.e.	.013	.009	.013	.007	.007
HD 128 618	8.024	1.460	1.594	0.774	1.465
m.e.	.018	.008	.021	.006	.006

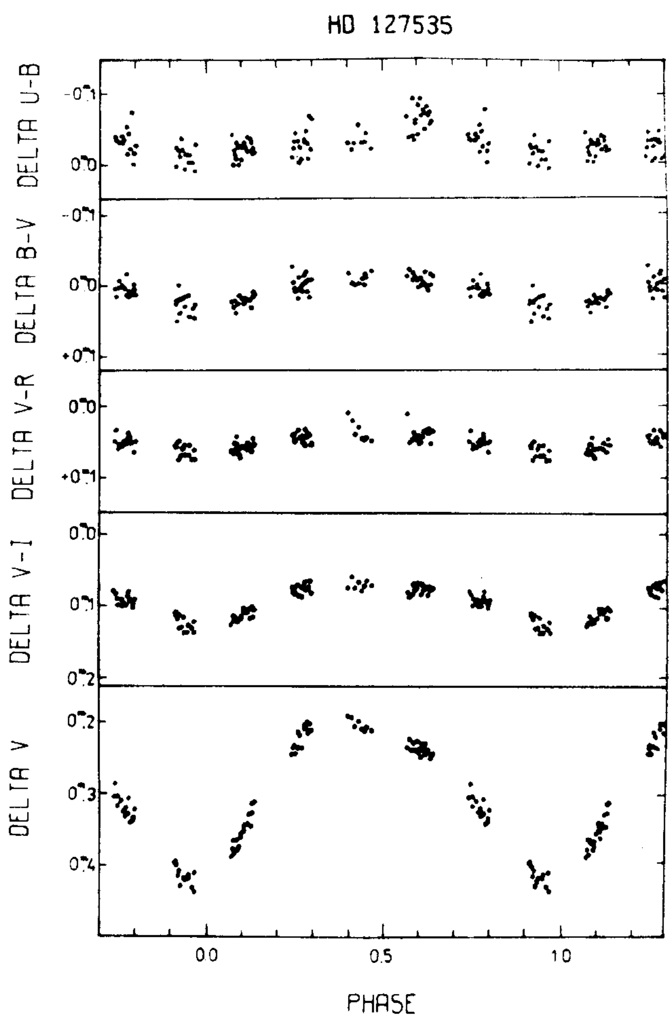

Figure 1

The photometric variability of HD 127 535 was now established beyond any doubt: during our observations the star showed a light curve amplitude $A_V = 0\overset{m}{.}25$. We could derive a light curve period of $P_p = 5\overset{d}{.}97$ by using a "phase dispersion minimization" method (PDM) as described by Stellingwerf (1978). Due to the fact that only two cycles were covered during our observational run, the PDM-method yields an accuracy of about 25% for the period which thus should be considered preliminary. On the other hand the inspection of the light and colour curves (see Figure 1) derived with the light elements:

$$\text{Min. (J.D.hel.)} = 2445804.10 + 5\overset{d}{.}97 \cdot E$$

indicates that the error of the thus derived period is smaller than the PDM-method yields. Within the limits of accuracy the photometric period is identical with the orbital one given by Collier (1982), which suggests synchronized rotation if the light variations are interpreted due to the rotation of one or both components covered with subluminous photospheric areas. The photometric period which was given by Collier (1982) is $6\overset{d}{.}03$, also close to our value. Unfortunately he does not list the time instants of the minimum or maximum, so it is impossible to improve the photometric period, which would be possible if the subluminous areas were stationary in size and position on the stellar photosphere. Further photometric observations could therefore solve this problem.

The magnitude and colour differences in Figure 1 have the sense 'variable minus comparison'. The mean values of V and colours of HD 127 535 as well as the light and colour curve amplitudes are listed in Table II, and time instants of the extreme values of the light curve in Table III.

Table II. The average colours and V magnitudes of HD 127 535 and the observed light and colour curve amplitudes in 1984

V	A_V	B−V	A_{B-V}	U−B	A_{U-B}	V−R	A_{V-R}	V−I	A_{V-I}
$8\overset{m}{.}63$	$0\overset{m}{.}25$	$1\overset{m}{.}07$	$0\overset{m}{.}07$	$0\overset{m}{.}77$	$0\overset{m}{.}09$	$0\overset{m}{.}62$	$0\overset{m}{.}06$	$1\overset{m}{.}19$	$0\overset{m}{.}08$

Table III. Minimum and maximum time instants of the 1984 light curve of HD 127 535 in J.D. hel.

Min.	Max.
2445810.07	2445806.25

The V-light curve is asymmetrical with a steeper rising branch and has an amplitude of $0\overset{m}{.}25$. Variations of all observed colour indices are well established and are correlated with the V luminosity, i.e. the star is redder near the minimum light. Such a correlation is supposed to be common to spotted stars suggesting that the dark and cooler photospheric areas which are responsible for the light variations, due to rotation are pointing towards the observer. Furthermore, the larger scatter of the (U-B)-colour curve indicates that we observe individual chromospheric calcium 'plages' appearing and/or disappearing at the limb of the stellar disc. Thus the photometric properties of HD 127 535 resemble the characteristics of the RS CVn group of chromospherically active stars. The star shows also all other RS CVn characteristics like duplicity, emission of the Ca II H and K and the Hα Balmer lines, and the location above the main sequence in the HR diagram. The chromospheric activity level in RS CVn stars differs from star to star and depends on the rotational angular momentum (Geyer, 1981). For most of such active stars the spotted areas change in size and position. Therefore the light curve is changing itself on time scales of years or even months. If our interpretation of the photometric behaviour of HD 127 535 is right, it must be considered as one of the most active stars of the RS CVn-group. Collier (1982) reports that the amplitude of the V light curve was only $0\overset{m}{.}06$ in 1981. Thus the amplitude increase from this value to our 1984 value by $0\overset{m}{.}19$ has taken place within only three years. Furthermore, the total brightness of the system dropped by about $0\overset{m}{.}2$ in V within this time interval. Better insight into the activity phenomenon of this star might be gained only by future multicolour photometric and especially spectroscopic observations of the H and K line profiles, above all for possible activity cycle which might have a length of about 6 years.

Finally it should be noted that the northern RS CVn star II Peg (=HD 224 085) shows a similar behaviour for the strong light curve variations on a three year time scale (Bohusz and Udalski, 1981; Ramsey and Nations, 1984). The observed properties of HD 127 535 resemble so much II Peg that we may call HD 127 535 "the southern twin of II Peg".

A. UDALSKI[1,2] and E.H. GEYER[2]

[1] Warsaw University Observatory
Al. Ujazdowskie 4
00-478 Warszawa, Poland

[2] Observatorium Hoher List
der Universitats-Sternwarte Bonn
D-5568 Daun, F.R. Germany

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PHOTOELECTRIC MINIMA TIMES OF ER ORIONIS

The short period ($P = 0^d.4234$) eclipsing binary ER Orionis was observed photoelectrically during 1982 and 1983. The observations were made using the two-beam, multi-mode, nebular-stellar photometer attached to the 48 inch Cassegrain reflector at the Kryonerion Astronomical Station of the National Observatory of Athens.

During our observations six new minima times were obtained. They are presented in the following Table, the successive columns of which give: the Hel. J.D. of the six minima, the residuals (O-C), the mean error σ and the type of minimum.

Table I

Hel.J.D. 2440000+	(O-C) days	σ days	Min. Type
5310.4163	-0.0277	±0.0003	I
5311.4771	-0.0244	±0.0004	II
5312.3233	-0.0250	±0.0004	II
5312.5322	-0.0278	±0.0003	I
5380.2774	-0.0268	±0.0003	I
5667.5369	-0.0248	±0.0004	II

The residuals (O-C) have been computed using Kukarkin's et al. (1976) ephemeris formula:

$$\text{Min I} = (\text{Hel.J.D.})\ 2436508.7851 + 0^d.4234009\,E$$

while the times of minima and the mean errors have been calculated using Kwee and Van Woerden's method (1956).

P. ROVITHIS

National Observatory
of Athens, Athens 11810
Greece

H. ROVITHIS-LIVANIOU

Astronomy Department
Athens University
Panepistimiopolis
GR-157 71 Zografos
Greece

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UBVR PHOTOMETRY OF NQ Her

NQ Her was observed on 23 nights during the period from June to December 1979 using the 50-cm reflector of the Mountain Station "Terskol" of Main Astronomical Observatory of the Ukrainian Academy of Sciences.

The data were obtained with a single-channel photon-counting automatic photometer with a PEM-79 uncooled photomultiplier tube. The photometer employed a combination of glass filters designed to match the standard UBVR system. Differential measurements were made using BD+ 18°3580 ($7^{m}.6$, Sp A3) as comparison star and BD+18° 3582 ($7^{m}.2$, Sp A2) as check.

The average standard deviations of a single measure of the comparison star in U, B, V and R filters are:

$$\sigma_U = 0^{m}.016 \; ; \quad \sigma_B = 0^{m}.012 \; ; \quad \sigma_V = 0^{m}.010 \; ; \quad \sigma_R = 0^{m}.010$$

respectively. The measurements showed that the magnitude differences between the comparison and check stars were constant:

$$\Delta U = 0^{m}.618 \pm 0^{m}.010 \; ; \quad \Delta B = 0^{m}.728 \pm 0^{m}.009 \; ; \quad \Delta V = 0^{m}.636 \pm 0^{m}.005 \; ; \quad \Delta R = 0^{m}.508 \pm 0^{m}.004$$

The mean V magnitude and the colour indices U-B, B-V, and V-R of the comparison star have been determined from observations of UBVR standard stars:

$$V = 8^{m}.034 \; ; \quad U-B = 0^{m}.033 \; ; \quad B-V = 0^{m}.351 \; ; \quad V-R = 0^{m}.381 \; .$$

The instrumental magnitudes have been converted into standard magnitudes with the help of several standard stars chosen from the list of Johnson et al. (1966). Due to the angular proximity of the variable and comparison star no corrections for differential extinction were necessary. The mean V magnitude and the mean colour indices U-B, B-V, and V-R of all the observations of the variable star are given as follows:

$$V = 8^{m}.463 \; ; \quad U-B = -0^{m}.044 \; ; \quad B-V = -0^{m}.028 \; ; \quad V-R = 0^{m}.089 \; .$$

No brightness variations have been detected within the errors. It was not possible to extract any periodicity from our observational data. For the phase computations the elements of Kukarkin et al. (1970) are used:

$$J.D.(V_{min.}) = 2426894.433 + 0^{d}.870218\,E$$

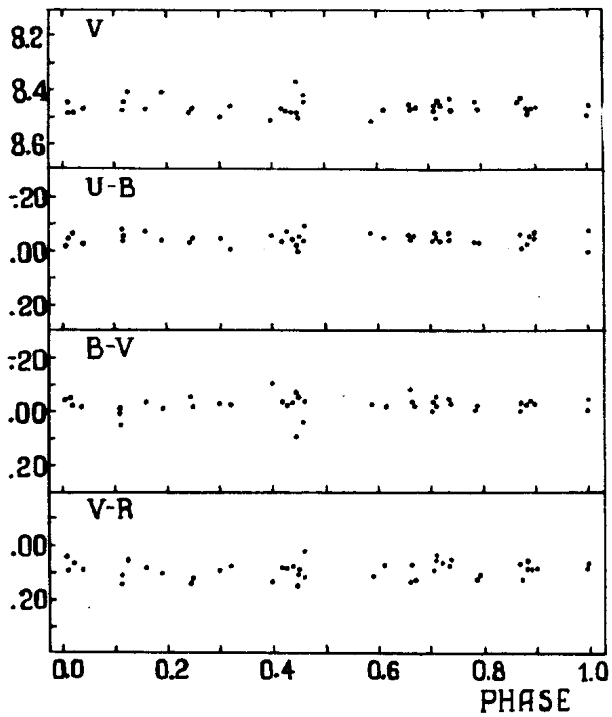

Figure 1

In Figure 1 the observations in V light and the colours U-B, B-V, and V-R are plotted versus phase. The inspection of Fig. 1 leads to the conclusion that NQ Her did not show any variability with the period of $P = 0^d.870218$. Our results agree with those obtained by Rossati (1964), Schneller (1965), Popovici (1971), Blanco (1971), Bozkurt et al. (1975) and Padalia (1975).

However, the absence of any notable brightness variation in NQ Her at present is not an evidence of the constancy of NQ Her in general. It is possible that a weakening of the variable star photometric activity followed the active phase when the photographic observations had been made.

G.A. VOITENKO and G.U. KOVALCHUCK

Main Astronomical Observatory
of the Ukrainian Academy of Sciences
Kiev, U.S.S.R.

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TIMES OF MAXIMUM LIGHT OF THE β CMa STAR BW VULPECULAE

An extensive study of the times of maximum light of BW Vul was carried out by Valtier (1976). In it he considers all the available photometric and spectroscopic data in view of the importance of establishing rates of period increase for comparison with theoretical models of the stars. Valtier finds that, in agreement with Cherewick and Young (1975), all the observations can be fitted by a unique ephemeris if one considers that the period is linearly increasing with a rate of 1.8 s/century.

In view of the importance of this result, some additional observations were carried out at the Observatorio Jose Arbol y Bonilla, Zacatecas, Mexico, with the 50 cm telescope in the UBV system with a 1P21 uncooled phototube. The comparison stars were HD 199102 and HD 198527, except in 1982 when HD 198820 and HD 198527 were utilized.

Table I lists the new times of maximum light for BW Vulpeculae. The photometric data and the analysis of periodicity will be published elsewhere.

Table I. Times of maximum light of BW Vulpeculae

H.J.D.	H.J.D.	H.J.D.
44117.7225	44153.7070	44475.7782
44142.6620	44155.7220	44500.7160
44143.6560	44157.7378	44505.7409
44144.6560	44159.7490	45230.6945
44146.6773	44163.5651	45231.6977
44149.6950		

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M. RIOS HERRERA[1], M. RIOS BERUMEN[1],
J.H. PENA[2] and R. PENICHE[2]

[1] Universidad Autónoma de Zacatecas,
Apdo. Postal 275, Zacatecas, Zac., México

[2] Instituto de Astronomia
Universidad Nacional Autónoma de México
Apdo. Postal 70-624, 04510 México, D.F. México

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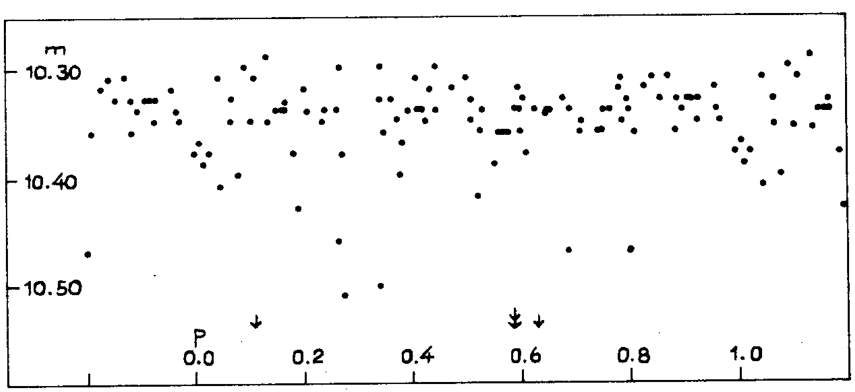
ON THE SUPPOSED PERIODICITY OF IP PERSEI

99 Sonneberg photoelectric observations in the V band of IP Persei, in general classified as an Isa star, show no signs of the 1.94672 day periodicity suggested by Kardopolov and Filip'yev in 1981 in Perem. Zvezdy 21, p.688 (1982), which unfortunately arrived at our library not before August 1984.

Our observations were discussed already in Mitt. Veränderl. Sterne 8,p.53 (1978); they were obtained mainly in the years 1968 to 1976. It cannot be completely excluded, although it seems to me not plausible, that the "eclipsing" variability is restricted to some episodic time interval(s).



The figure shows our V data folded by the mentioned "period". The four arrows indicate observations which are much fainter than the limitations of the drawing. Their clustering and spacing by half of the period is meaningless and is caused by the 1.0 or 2.0-day intervals between the measurements in connection with the assumed length (≈2 days) of the period. These arrowed observations form the minimum depicted in Mitt. Veränderl. Sterne 8, p. 55 (fig. 2).

W. WENZEL
Sternwarte Sonneberg
Zentralinstitut für Astrophysik
Akademie der Wissenschaften der
DDR

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PHOTOELECTRIC OBSERVATIONS OF THE RECENT ECLIPSE OF 22 VULPECULAE

The spectroscopic binary 22 Vulpeculae (BD +23°3944) was noted by Parsons and Ake (1983 Inf. Bull. Var. Stars No. 2334) to have recently undergone an eclipse. Their conclusion was based upon IUE spectra from April 1983 in which the spectrum of the hotter companion was absent and the FES magnitude (λ_{EFF} 5200 Å) was 0.12 magnitude fainter than on previous occasions. With a revised period they gave the approximate ephemeris:

$$2445442.2 + 249.099E.$$

To confirm 22 Vul as an eclipsing binary, it was observed on seven nights during August and September 1984 with the 41 cm. reflector of the Morgan-Monroe station of the Goethe Link Observatory. All observations were made with standard UBV filters and a 1P21 photomultiplier tube cooled with dry ice. Differential measurements were made in the pulse counting mode using BD +24°4075 as a comparison star and BD +23°3935 as a check star. A neutral density filter was used to reduce the brightness of the stars involved. Calculation showed that the largest dead time correction was less than 0.5%, hence dead time corrections were not applied. Because the variable and comparison stars are separated by more than 1°, corrections for differential extinction were applied. No attempt was made to transform to the standard system. The check star varied by less than $\pm 0\overset{m}{.}01$ in B and V and less than $\pm 0\overset{m}{.}02$ in U.

The differential magnitudes are plotted in Figure 1. From this plot several conclusions can be drawn:

1. An eclipse did occur.
2. The depth of the eclipse was approximately $0\overset{m}{.}05$ in V, $0\overset{m}{.}10$ in B and $0\overset{m}{.}30$ in U.
3. Duration of totality was at least eight days, as noted by Parsons and Ake.
4. Mid-eclipse occurred no earlier than J.D. 2445941.6, more than a day later than predicted by the above light elements.

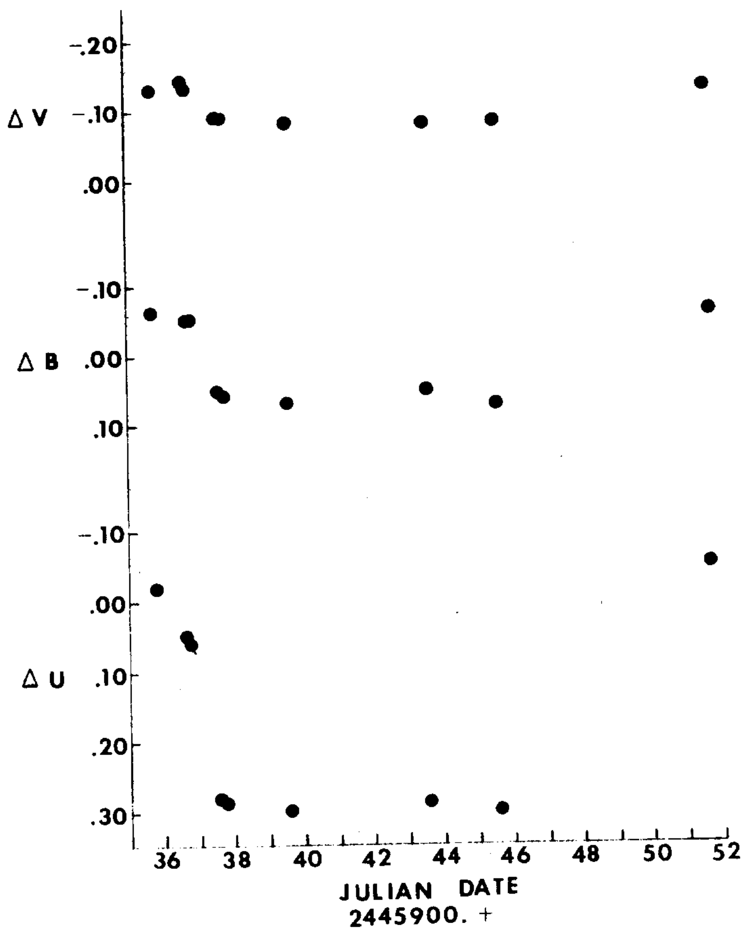

Figure 1

DANNY R. FAULKNER
Astronomy Department
Swain West 319
Indiana University
Bloomington, IN 47405 U.S.A.

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LONG PERIOD VARIABLE CARBON STARS AT GALACTIC LONGITUDE 86°

To search for light variations and study variability of carbon stars the 80 cm Schmidt telescope at the Baldone station of the Radioastrophysical Observatory was used for monitoring all known accessible C-stars situated in five-degree wide zone streched perpendicular to the galactic equator between latitudes $+9^{\circ}.5$ and $-9^{\circ}.5$ and centered at longitude 86°. In each of the five partly overlapping fields of 5°-diameter 50 - 75 red plates, 13 - 32 visual films and 20 - 23 blue plates were taken. The observations span 11 years from 1972 to 1983. Because of the largest number of observations the red (m_R) magnitudes, best of all, indicate the existence of light variations and display their properties. Preliminary results for some of the stars were given earlier (Alksne et al., 1983).

Characteristics of variations observed in red light for long period variable stars are summarized in Table I. The name for known or suspected variables or the (four-digit) number according to Stephenson (1973) or the number according to the catalogue of Baldone carbon (BC) stars (Alksne et al., 1980, 1983; Alksnis and Ozolina, 1983; Star catalogue and files available at the stellar data center, 1982), the epoch of the maximum brightness (M_o), the period in days (P), the m_R-magnitude at maximum ($\overline{m}_R$ max) and minimum ($\overline{m}_R$ min) light of the mean light curve and the total range (Δm_R) of m_R-variations are given.

Additional information for several stars follows.

V Cyg. After J.D. 2 444 150 $\overline{m}_R$ max = $6^m.9$, $\overline{m}_R$ min = $8^m.8$ and the shape of the mean light curve differs from the earlier observed one, in addition, secondary oscillations with $P_2 \approx$ 2P and m_R-range of $1^m.2$ seem to start.

BC 48. Very large range ($2^m.0$) secondary variations with maxima at J.D. 2 442 050 and 2 443 550.

U Cyg. Slow secondary variations, m_R-range $0^m.5$, time scale about 6P.

V 1426 Cyg = CIT 13 = IRC+40 485 = AFGL 2781.

2946. Stable light curve, bump at phase 0.7 .

Table I

Star	M J.D. 24....	P	$\overline{m}_R$ max	$\overline{m}_R$ min	Δm_R
V Cyg	1091*	$421^d.43$*	$7^m.70$	$9^m.80$	$3^m.7$
BC48	2050	496	11.44	12.94	3.0
U Cyg	2246	462.4*	6.08	8.44	2.9
V1426 Cyg	1420	482	9.24	11.04	2.5
2946	1917	424	11.34	13.02	2.0
BC245	2000	350	12.2	13.3	2.0
BC236	1775	401	13.20	14.16	1.9
BC244	1940	356	11.2	13.1	1.9
V1555 Cyg	1559	518	12.39	13.89	1.9
BC240	1924	457	13.38	14.28	1.6
V1554 Cyg	1690	330	11.4	12.6	1.4
BC40	2250	345	10.40	11.23	1.1
BC242	1847	405	12.24	13.40	1.1
BC243	2675	361	12.3	13.0	0.8
BC41	3305	381	10.5	10.9	0.7
NSV 12973	2250	413	8.60	9.00	0.6
V1541 Cyg	1550	370	10.16	10.50	0.4

* from Kukarkin et al., 1976, III Suppl. to the III Edition of the General Catalogue of Variable Stars.

BC 245. Secondary variations with m_R-range $1^m.6$ and large changes of amplitude in different cycles.

BC 236. Variations of the light curve from cycle to cycle and gradual brightening of the star by about $0^m.5$ during the observing interval.

BC 244. Stable light curve, steep ascending branch (M-m = 0.35) not typical for carbon long period variables as observed also for MQ Cyg.

V 1555 Cyg. Secondary variations with m_R-range $1^m.4$ and possible cycle length 4 - 5 P .

BC 240. Large dispersion observed in ascending branch of the mean light curve.

V 1554 Cyg. Rather stable light curve.

BC 40. Small ($0^m.4$) secondary variations with time scale about 5-6 P .

BC 242. Small change of the shape of the mean light curve after J.D. 2 443 900.

NSV 12973. Very slow gradual fading by about $0^m.3$ during our observing interval.

For the 39 carbon stars not included in Table I the m_R-ranges are $0\overset{m}{.}3$ - $0\overset{m}{.}9$ and light variations less regular or irregular. The rest seven of the measured carbon stars seem to be non-variable judging from dispersion of their m_R and m_V values.

A. ALKSNIS and Z. ALKSNE

Radioastrophysical Observatory
Latvian Academy of Sciences, Riga
Latvia, U.S.S.R.

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